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Response to Further Information Request

Derryclare Wild Western Peatlands Project

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Appendix 5 – Geological, Hydrological & Hydrogeological Responses to Submissions prepared by HES

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1. INTRODUCTION

1.1 Preamble

MKO have been instructed by Coillte Teoranta, (the applicant) to prepare this report in response to the Further Information Request issued by Galway County Council on the 19th of April 2023 under Planning Reference No. 23/60. The further information request is made in relation to the planning application to remove approximately 343 hectares (ha) of coniferous forestry plantation for the purposes of peatland restoration in the townlands of Derryclare and Cloonnacartan in Co. Galway. The full development description as per the public notices, is as follows:

'*Coillte Teoranta (the applicant) seek a ten-year planning permission for development on a site located in the townlands of Derryclare (also known as Doire an Chláir) and Cloonnacartan (also known as Cúil na Ceártan), Co. Galway. The development will consist of the following:*

i. The felling/removal of some 343 hectares of conifer plantation for the purposes of peatland restoration and the establishment of native woodland.
ii. Measures to restore and rehabilitate approximately 281 hectares of Atlantic blanket bog and heathland that is currently planted with lodgepole pine and Sitka spruce forests and managed for commercial forestry.
iii. Conversion of 62 hectares of conifer forestry to native woodland.
iv. Main peatland restoration measures will include tree removal, drain blocking (manual and mechanical) and ground reprofiling.
v. The control of existing invasive species on site and continued control during the restoration works to prevent their spread.
vi. Drain-blocking all existing artificial drainage and artificial land drains currently existing within the peatland restoration areas in order to restore the high water table which is necessary for blanket bog growth
vii. Provision of silt traps at outflows to block the pathway to the Twelve Bens/Garraun Complex Special Area of Conservation.
viii. Deer fencing to protect 62 hectares of proposed native woodland
ix. Provision of a Harvest Management Phasing Plan for the proposed project.
x. Provision of new internal access road extending to 1.58 km
xi. Across the site there will be 4 no. temporary water-crossings constructed in order to facilitate the harvesting of the timber at the site.
xii. Provision of informational signage.
xiii. Resurfacing of up to 8.23 km of existing forestry roads.
xiv. Resurfacing of existing car park to facilitate public access.
xv. Installation of water monitoring stations for real time water monitoring during operations.
xvi. Cutting of roadside trees to improved sightline visibility at site entrance.
xvii. The application is supported by an Environmental Impact Assessment Report (EIAR) and a Natura Impact Statement (NIS).

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This report replies on a point-by-point basis to the 5 no. points requesting Further Information as set out in the letter received by the Planning Authority dated 19th April 2023. Please note that the information contained in this response should be read in conjunction with the EIAR as submitted with the planning application.

We wish to highlight that the applicant has engaged with the NPWS, a key stakeholder, with regard to the content of the response to Further Information prior to submitting the response to Galway County Council.

Should you require further clarification on any aspect of this response, please do not hesitate to contact this office.

1.2 Emerging Legislation

The European Union's (EU) ambitious Nature Restoration Law[1] aims to achieve the long-term recovery of ecosystems across the EU. It is estimated that approximately 85% of EU protected habitats are currently in poor condition. The Law aims to reverse this decline by improving the structure and function of ecosystems with the overarching objective of improving resilience and biodiversity. Measures to reverse ecosystem decline include improving habitat connectivity, significantly reducing the use of chemical pesticides and fertilisers and rewetting drained peatlands.

The Law will require the development of national restoration plans and sets out legally binding targets requiring member states to implement restoration measures to cover at least 20% of EU land and sea areas by 2030. There are also specific requirements around the restoration of peatlands with a target to restore 30% of drained peatlands under agricultural use by 2030 and 50% by 2050. With peatlands playing an important role in mitigating the impacts of climate change, the restoration of peatland ecosystems is an essential means of combatting climate change. It is intended these measures will bring the EU's ecosystems back into good condition, thereby enhancing biodiversity and ensuring the continued delivery of key ecosystem services.

In November 2023, the Council presidency and European Parliament representatives reached a provisional political agreement on the proposed rules. This provisional agreement now has to be endorsed and formally adopted by the European Council and the Parliament. In terms of the Parliament, the Law passed the Environment Committee on the 29th of November. The vote of the full Parliament is expected to occur in the first quarter of 2024. If adopted, the Law will be published in the EU Official Journal and enter into force 20 days later.

The objective of the Wild Western Peatlands Project is to restore and rehabilitate approximately 2,100ha of Atlantic blanket bog and wet heath along the western seaboard of Ireland - that is currently planted with poorly performing inappropriate spruce and pine forests - to enhance biodiversity and improve carbon storage in the landscape. The subject site at Derryclare has been chosen as the pilot site for the Wild Western Peatlands project, and further Coillte sites will be selected to make up the 2,100 hectares of the total Wild Western Peatlands project in the coming years. It is considered that the proposed development appropriately aligns with the objectives set out in the Nature Restoration Law, as it will provide for the restoration of approximately 281 hectares of Atlantic blanket bog and heathland.

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[1] https://www.rte.ie/news/world/2023/1110/1415887-eu-nature/

2. FURTHER INFORMATION ITEM NO.1

The submitted drawings do not fully and clearly represent the proposed development, please provide the following drawings for the purpose of clarity.

2.1 Part (a)

Site Plan - should clearly demonstrate both the existing and proposed land uses including those within the blue edge boundary- indicating the retained commercial forestry extents, new forestry, wet heath and blanket bog.

2.1.1 Response to Part (a)

An updated drawing of the site plan has been prepared as part of the Further Information response. The restoration plan drawing pack prepared by MKO illustrates both the existing and proposed land uses including those within the blue edge boundary – indicating the retained commercial forestry extents, new forestry, wet heath and blanket bog. Please refer to the submitted drawing pack prepared by MKO for further details. Restoration maps have also been completed to address concerns, please refer to the enclosed Restoration Plan Compartment drawings within the **FI Drawing Booklet** prepared by MKO for further details.

There is no decision support tool currently developed in Ireland to prescribe restoration options on blanket bogs. Developing such a tool can help guide the planner in ensuring the most appropriate restoration option is applied based on the site conditions. A decision support tool was therefore developed using all best available practice guidelines, to produce a decision support tool to help inform management decisions. For the purposes of appropriate assessment, the mitigations applied for all restoration options correspond to the migrations needed for the restoration measure with the highest degree of disturbance and highest level of impact.

The applicant has developed a **Decision Matrix for selecting the Forest to bog restoration option** which is enclosed in Appendix 1. The decision matrix described in this document is a tool that can be used to select the restoration option best suited to the site, based on the site conditions, using the precautionary principle. The decision matrix requires key site data, and it allows the user to prescribe restoration options appropriate for the underlying site conditions. The purpose of the decision matrix is to find the restoration option that will cause the least disturbance and deliver the best restoration results and help guide the site manager in selecting the best restoration option for the site. The decision matrix can also be used to identify what restoration options are not suitable for the site. In all cases, alternative restoration options can be considered up to, but not above the prescribed option. This approach ensures the site is assessed on its ground conditions and provides useful guidance when planning restoration. The decisions are applied using the smallest management unit available, namely the sub-compartment. It should be noted that the decision matrix for selection of restoration options is designed to function as an aid to the restoration practitioner and that final decisions on appropriate restoration options should be made based on best professional judgment and on actual conditions encountered on the ground.

Please refer to the submitted Decision Matrix for selecting the Forest to bog restoration option for further details.

In addition to the restoration plan drawings, the applicant has prepared a Forest to Bog best practice guidance document which is submitted with this response. The guidance document outlines 9 no. steps to be adhered to in all forest to bog operations with step 3 relating to the preparation of a detailed restoration plan for the felled area as part of a site-specific operational plan. The document also includes a detailed literature review.

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This guidance document is further discussed under Item 3(d) of this report.

The applicant has additionally prepared a **Derryclare Restoration Plan for Practitioners** enclosed in Appendix 2 which acts as the practitioners quick reference to the Derryclare restoration plan. The plan includes the following:

1. An executive summary for practitioners.
2. A practitioners' management implementation plan (Table 1).
3. Relevant appendices with summaries for the following.
    a. Water monitoring plan.
    b. Invasive species plan.
    c. Grazing management plan (including deer management).
    d. General maintenance plan.
    e. Fire plan.

Please refer to Appendix 2 of this report for further details.

2.2 Part (b)

The sightlines have not been submitted in accordance with the required standard as set out in DM Standard 28 of the Galway County development Plan 2022-2028

2.2.1 Part (i)

i. Please submit a revised site layout plan that indicates visibility of 70m in both directions from the proposed access to the site, from a 2.4m setback from the road edge, and measured along the near road edge, at an object height of between 1.05m from the access to 0.6m at the sightline distance.

2.2.1.1 Response to Part (i)

The sightlines are now submitted as required by DM Standard 28 of the Galway County development Plan 2022-2028. Alan Lipscombe Traffic and Transport Consultants have prepared a response to address the information requested as part of Item No. 1 (b) (i) (ii) and (iii).

The 70m visibility splays taken from a 2.4m setback are shown at the existing access junction on the R344 in the horizontal plane in **Figure FI1.** The figure, together with Plates 1 and 2, show that the only existing obstructions within the visibility splays are shrubs and hedging. We confirm that the hedging will be maintained to 0.6 metres and is located entirely within Coillte's landownership. We confirm that approx. 25m of the northern visibility splay is located outside of Coillte's ownership and consists of a grass verge, which will not result in visibility obstruction.

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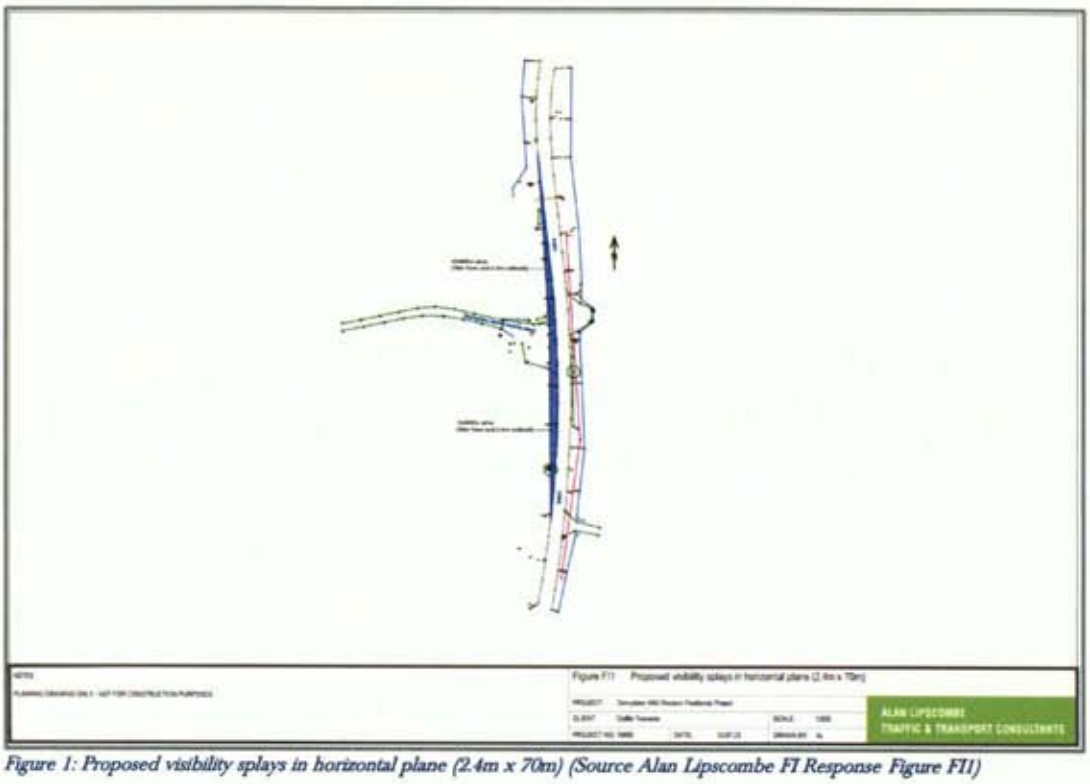

Figure 1: Proposed visibility splays in horizontal plane (2.4m x 70m) (Source Alan Lipscombe FI Response Figure FI1)

The profile of the existing carriageway edge on the R344, together with the visibility splay in a vertical plane are shown to the south and north of the existing access in Figure FI2. The figure shows that once the shrubs and hedging (which are located in Coillte's land ownership) are cleared, as set out above, the required visibility taken from a driver height of 1.05m to an object height of 0.6m is available in both directions.

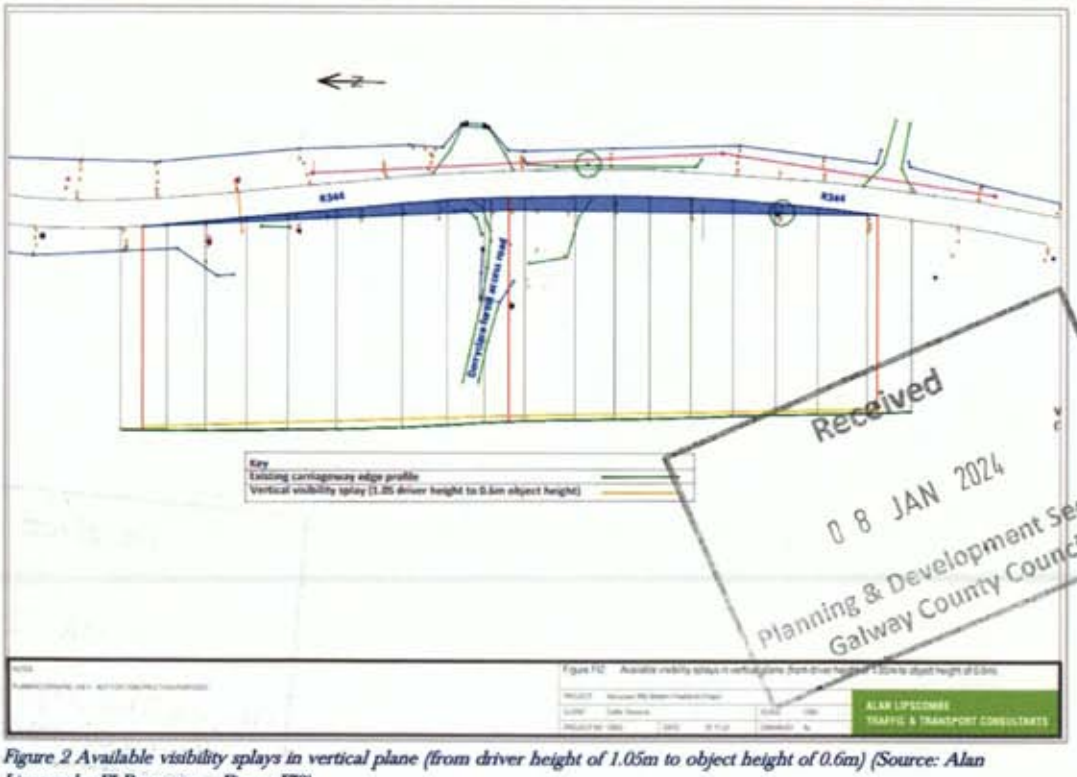

Figure 2 Available visibility splays in vertical plane (from driver height of 1.05m to object height of 0.6m) (Source: Alan Lipscombe FI Response – Figure FI2)

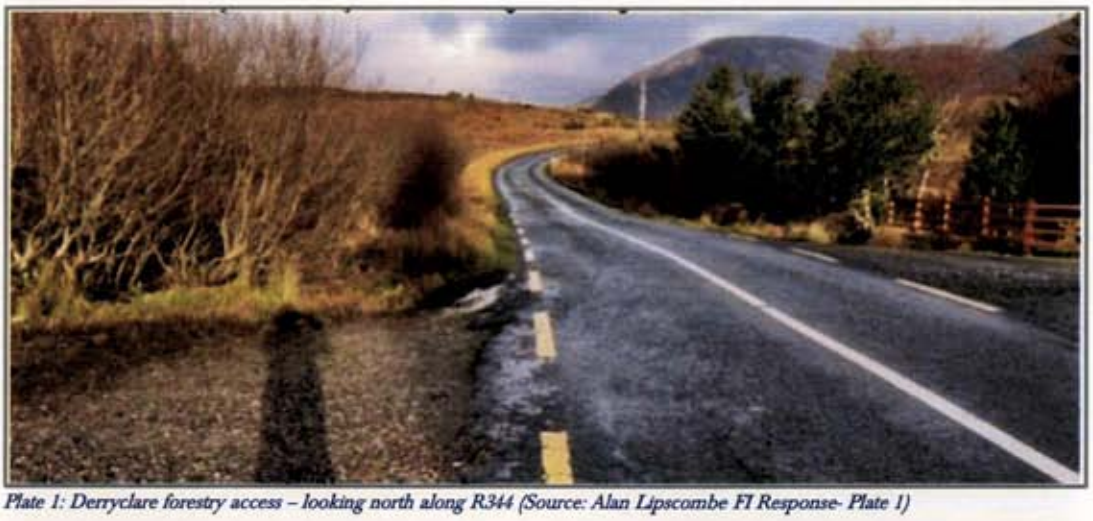

Plate 1: Derryclare forestry access – looking north along R344 (Source: Alan Lipscombe FI Response- Plate 1)

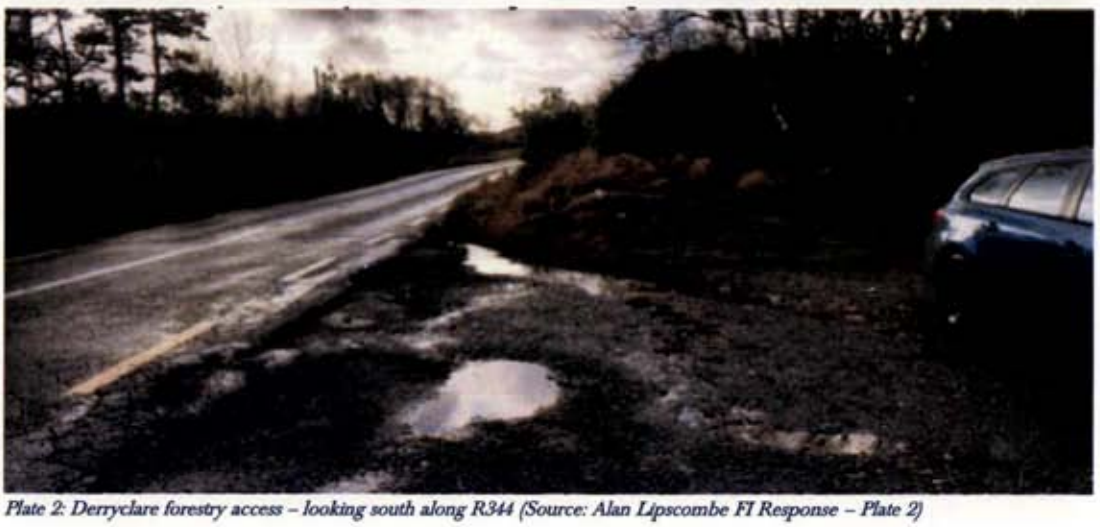

Plate 2: Derryclare forestry access – looking south along R344 (Source: Alan Lipscombe FI Response – Plate 2)

2.2.2 Part (ii)

ii. Where works are required in order to facilitate the provision of adequate sight distances, lands within the sight distance triangles shall be within the control of the applicant and shall be subject of a formal agreement with the adjacent landowner which ensures certainty that the applicant is in a position to comply with the relevant condition and or standard.

2.2.2.1 Response to Part (ii)

As referenced in item (i) above, We confirm that the hedging will be maintained to 0.6 metres and is located entirely within Coillte's landownership. We confirm that approx. 25m of the northern visibility splay is located outside of Coillte's ownership and consists of a grass verge, which will not result in visibility obstruction. All required works are within the applicants landholding and therefore third party consent is not required.

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2.2.3 Part (iii)

iii. The full extent of the roadside remedial works, the required consent for same and associated mapping of lands required for the provision and maintenance of sightlines outlined in blue on a site location map and site layout plan is therefore required to be submitted by the applicant.

2.2.3.1 Response to Part (iii)

Please refer to Figure 3 below which indicates the location of the required sightlines in the context of the applicants ownership boundary. As referenced in item (i) above, approx. 25m of the northern visibility splay is located outside of Coillte's ownership and consists of a grass verge, which will not result in visibility obstruction. All required works are within the applicants landholding and therefore third party consent is not required.
Please refer to Figure 3 below which indicates the location of the required sightlines in the context of the applicants ownership boundary. As referenced in item (i) above, approx. 25m of the northern visibility splay is located outside of Coillte's ownership and consists of a grass verge, which will not result in visibility obstruction. All required works are within the applicants landholding and therefore third-party consent is not required.

Figure 3: Sightlines in the context of the Blue Line Boundary (prepared by MKO)

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2.3 Part (c)

A drawing demonstrating each harvest block/ unit demonstrating the proposed phasing scheme including the schedule of works for both tree felling, any replanting and proposed restoration works of the project site should be provided.

2.3.1 Response to Part (c)

The phasing scheme was set out in the EIAR which was submitted with the application on 23/02/2023. To account for the Further Information response time, we have rolled the phasing plan forward by 1 calendar year. An updated drawing has been prepared which demonstrates each harvest block / unit in the proposed phasing scheme, including the schedule of works for both tree felling, replanting and proposed restoration works of the project site. Please refer to the submitted Proposed Harvest Phasing Map and Indicative Restoration Phasing Map contained in the **FI Drawing Booklet** prepared by MKO for further details.

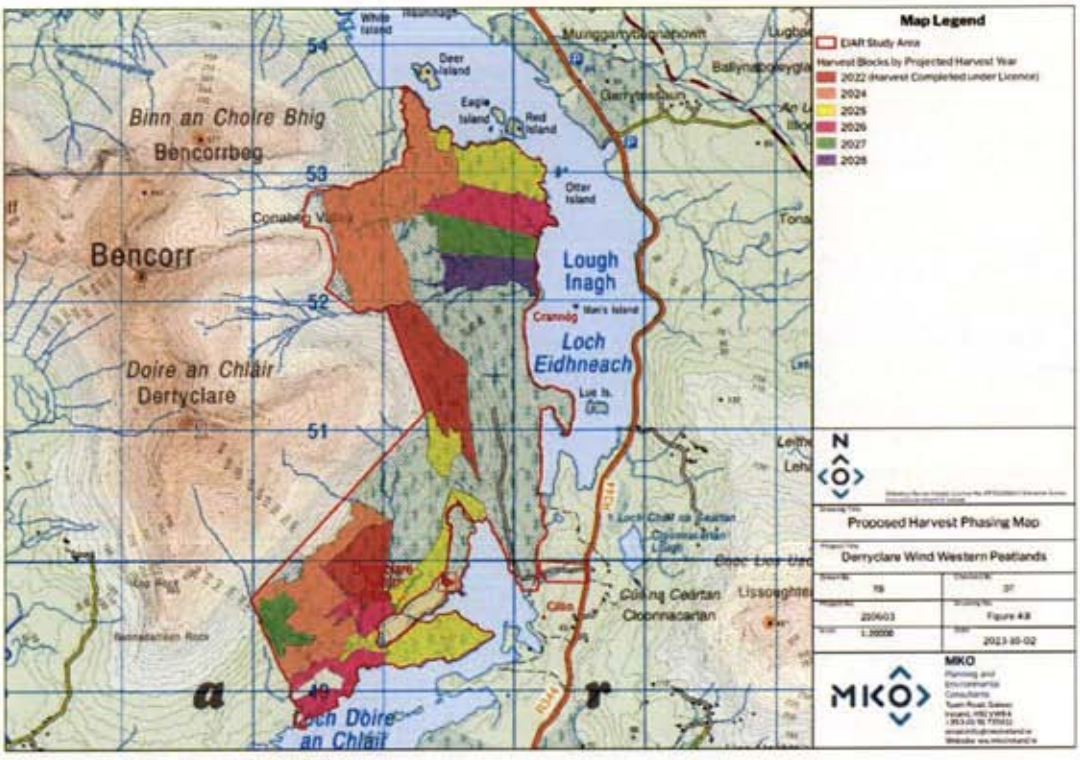

Figure 4: Proposed Harvest Phasing Map

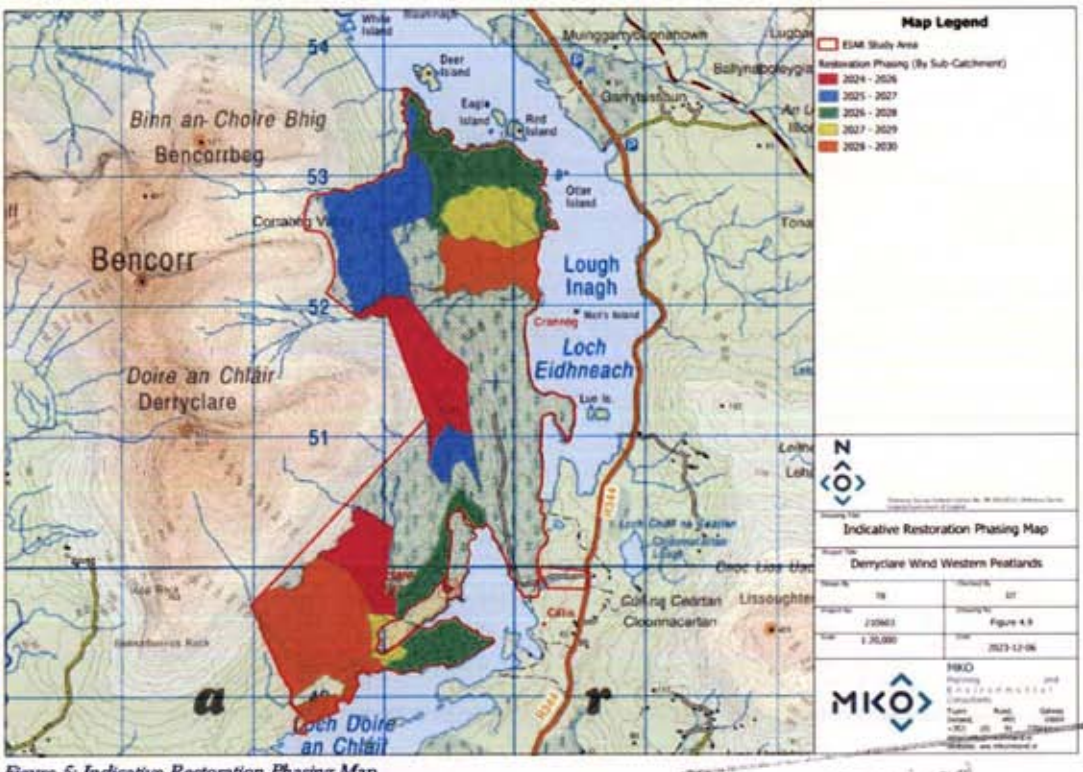

Figure 5: Indicative Restoration Phasing Map

Please refer to the submitted **FI Drawing Booklet** prepared by MKO for further details.

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2.4 Part (d)

An individual drawing of each harvest block/sub-unit demonstrating existing/proposed gradient details, peat depths, saturation levels and precise proposed methodology in each of proposed drain blocking, site reprofiling including finished ground levels, involved in the restoration/replanting scheme specific to each sub-unit.

2.4.1 Response to Part (d)

An updated drawing of the harvest block/sub compartment have been updated accordingly and are re-submitted. Please refer to the updated restoration plan drawings within the **FI Drawing Booklet** prepared by MKO for further details.

2.5 Part (e)

Drawings need to clearly demonstrate at an appropriate scale the layout at the entrance to the site including full car park details & location of proposed signage.

2.5.1 Response to Part (e)

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The drawings have been updated to clearly demonstrate at an appropriate scale the layout at the entrance to the site including full car park details and location of proposed signage. Please refer to drawing no. 210603 – 14 within the **FI Drawing Booklet** prepared by MKO for further detail.

2.6 Part (f)

Full mapped details of the extent of the 8.23 km of resurfacing of internal roads works proposed and the 1.58km of new internal access road should be provided.

2.6.1 Response to Part (f)

The submitted Site Layout Plan drawing no. 21060304 to 21060309 inclusive as submitted with the planning application provided a road plan of the 8.23 km of resurfacing of internal roads works proposed and the 1.58km of new internal access. Chapter 4 of the submitted Environmental Impact Assessment Report (EIAR) includes the details of the proposed road plan.

Section 4.5.3 of the submitted EIAR states: *"Maximum use has been made of the existing on-site roads in accessing the proposed harvest blocks for timber extraction and bog restoration. All site access roads that are proposed to be used as part of the Proposed Project, both existing and proposed, will be capped with clean stone to minimise the risk of sediment runoff to local water courses. The material required for upgrade and construction of roads within the site will be obtained from local, licenced quarries".*

Section 4.5.3 of the submitted EIAR describes the existing roads "*The existing roadways and tracks through the site will be used to access the proposed timber harvest blocks and restoration areas. It is proposed to use 8.23 kilometres of existing on-site roadways as part of the Proposed Project. While some upgrading of these roadways may be required, it is not anticipated any widening of the roadways will be required. Upgrading of the existing roadways will involve the laying of a new surface dressing on the existing section of roadway only where necessary".*

Section 8.5.2.5 of the submitted EIAR describes that locally sourced stone compatible with the local geology will be used to upgrade the road network "The upgrade of the existing road network will only

be completed where necessary using local stone compatible with onsite geological materials". Please refer to Chapter 4 of the submitted EIAR and drawing no. 21060304 to 21060309 for further details regarding the road map plan.

As referenced in Section 4.5.3 of the EIAR, it is proposed to construct approximately 1.58 kilometres of new roadway as part of the Proposed Project. The routes of the proposed new roads are shown in Figure 4.3. Proposed new access roads will be designed as "Build On-Top Embankment Roads" in accordance with the COFORD (2004) Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads.

Along the new road there will be 4 no. temporary water-crossings of natural water courses constructed in order to facilitate the harvesting of the timber at the site. Full details of the proposed crossing methods for each watercourse crossing, along with a map of their locations are provided in Appendix 4-1 of the submitted EIAR. Additional temporary water course crossings of forestry drains may also be required to facilitate timber harvesting. These additional crossings will be accomplished using the same methodology described in Section 4.7.9 of the EIAR however, all forest drains within the project site will be permanently blocked as part of the proposed peatland restoration. Temporary Watercourse Crossings will be removed following the completion of the restoration works.

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3. FURTHER INFORMATION ITEM NO. 2

The site of the proposed development is located surrounded by The Twelve Bens/Garraun Complex SAC, within c2km from Maumturk Mountains SAC and Connemara Bog Complex SAC and SPA, and within a distance of 15km of 9 no. other designated European site for rare and threatened flora and fauna across the European Union (i.e. Natura 2000 network of sites), which are protected under the EU Habitats Directive (92/43/EEC) & EU Birds Directive (79/409/EEC, as amended by Directive 2009/147/EC) and the European Communities (Natural Habitats) Regulations 1997, as amended by the European Communities (Birds and Natural Habitats) Regulations 2011. The protection of these European sites is further reinforced in the Galway County Development Plan, 2022-2028, which was subject to a Natura Impact Report NIR and includes the following provisions to protect European Sites: Policy Objective NHB 1, Policy Objective NHB 2, Policy Objective NHB 3, Policy Objective NHB 4, Policy Objective WR 1 Water Resources, and DM Standard 50. Based on the information included with the planning application, and the concerns identified by the Planning Authority in relation to the potential direct, indirect and cumulative impacts which include Annex I habitat loss and damage, uncertainties in terms of mitigation measures proposed, deficiencies in the information contained in the NIS concerning potential impacts of the project on Qualifying interests of the European Sites. The planning authority in conjunction with the application of the precautionary principle, consider that adverse effects on the integrity and conservation objectives of the European sites in the vicinity, cannot be ruled out, as a result of the proposed project. Therefore, the Planning Authority requires the applicant to provide and update the submitted NIS accordingly including the following required information:

The issue of mobile species using this 567ha site is not fully addressed in the absence of dedicated surveys. For each field survey undertaken provide: Brief description of methodology/method, Names and qualifications of surveyors, Date(s) of surveys, Study area, Weather conditions at time of survey(s) and time of day (if relevant), Reference to relevant guidance document (where appropriate), Explanation of any departures from recommended guidance. Limitations Note: Where multiple survey visits have been undertaken, dates, times and weather conditions of surveys can be provided in a table in an appendix. Note: Detailed descriptions of survey method can be provided in an appendix.

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In response the RFI received from GCC, particularly Item 2, a suite of additional surveys of the Proposed Project site were undertaken by MKO ecologists and Coillte Nature, pertaining to mammals, birds, bats, and watercourses. Targeted surveys of each were undertaken and specific reports for each, detailing methodologies, results, and recommendations, have been included as part of this response to the RFI.

In light of the additional information obtained from these surveys and reports, Chapter 6; Biodiversity of the submitted EIAR was reviewed to determine whether amendments to its conclusions were required. In addition, the additional detail pertaining to the sub-compartment restoration plan, which is provided in this response to the RFI, was also considered.

Taking cognisance of the residual impacts as a result of the Proposed Project, post implementation of the mitigations set out in the respective reports for mammals, birds, bats, and water quality, as well as those already detailed in Section 6.7 of the submitted EIAR, it has been determined that the conclusion of Chapter 6; Biodiversity remains valid and there is no requirement for amendments.

3.1 Part (a)

Full Bird Survey Report, focusing on breeding bird or winter /wetland bird surveys paying particular attention to Merlin, Golden Plover, Common Gull and Cormorant. (Merlin identified as breeding on an island on Lough Inagh) Bird Surveys guidance should be followed – Institute of Ecology and Environmental Management Guidance Document states;

"It is however, an underlying presumption of these guidelines that bird surveys (breeding/non-breeding) should always be scoped in unless robust justification can be provided as to why they are not required. This presumption is due to the wide range of habitats that may be of value to bird species, seasonal variations in habitat use and/or value, the mobility of bird species and the potential sensitivity of bird species to a range of impacts that may result from development projects." Appropriate seasonal bird surveying shall be carried out and submitted.

3.1.1 Response to Part (a)

Pre-commencement surveys will be carried out on site as proposed within the planning application.

Breeding bird surveys were conducted at the proposed development site in breeding season 2023 in response to the RFI from Galway County Council. The survey scope was designed to target merlin, cormorant, common gull and golden plover. Other incidental observations birds of conservation concern observed during these surveys were recorded.

Merlin, cormorant and common gull were recorded at the proposed development site and in the adjacent Lough Inagh and Derryclare Lough during surveys. Through consultation with the National Parks and Wildlife Service during the preparation of the Biodiversity Chapter of the submitted EIAR, it was also confirmed that merlin were nesting in woodland on an island in south Derryclare Lough in the past. Although present in small numbers in Lough Inagh and Derryclare Lough, there was no evidence to suggest that cormorant or common gull are dependent on the area for breeding. Golden plover was not recorded during surveys.

The report concludes that merlin were likely breeding in north Derryclare Lough during breeding season 2023 and have been recorded breeding in other areas of the same lake during previous surveys, and that disturbance of breeding merlin on the north Derryclare Lough islet should be considered during the project works, and appropriate safe working distances applied.

For further details on this please see the **Bird Survey Report** by MKO.

3.2 Part (b)

Bat Survey Report, including the use of transect surveys and static detectors, any required mitigation measures identified for bat species.

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3.2.1 Response to Part (b)

A detailed **Bat Survey Report** has been prepared in response to Item 2b of the RFI from Galway County Council (GCC) which is submitted with the RFI response. The report includes the names and qualifications of the surveyors, desktop studies for the Proposed Project site, survey methodologies, results, an impact assessment on bats, and an overall conclusion. Bat surveys were carried out in accordance with Bat Conservation Trust - Bat Surveys for Professional Ecologists – Good Practice Guidelines (3rd edn.).

Bat surveys employed a combination of methods, including desktop study, habitat and landscape assessment, and manual activity surveys. The aim was to assess usage of the site by roosting, foraging and commuting bats to inform the ecological impact assessment. MKO completed dusk bat activity surveys and deployed static bat detectors throughout each season (Spring, Summer and Autumn). Surveys were undertaken by two licenced ecologists during suitable weather for bats.

In total, four species of bat and the Myotis genus were recorded across the proposed development site. No bat roosts were identified, and the site does not support potential for bat roosts. No significant direct or indirect impacts on roosting bat species are anticipated.

A moderate effect is anticipated on woodland-dwellers as a result of the loss of forest habitat, which is mitigated by the phased nature of the felling operations and the retention/re-creation of forest habitat (native scrub woodland) within the Proposed Project site and its surroundings.

Best practice disturbance limitation measures.

- All construction plant and equipment to be used on-site will be modern equipment and will comply with the European Communities (Construction Plant and Equipment) (Permissible Noise Levels) Regulations 1998, and any subsequent amendments.
- Plant machinery will be turned off when not in use. Machines, which are used intermittently, will be shut down during those periods when they are not in use.
- Operating machinery will be restricted to the proposed works site boundary.
- Reduced illumination of the site will be used where possible to prevent disturbance to bats that may potentially occur in the wider area. Where lighting is unavoidable during felling operations, low-intensity lighting and motion sensors will be used to limit illumination.

The report concludes that provided that the Proposed Project is carried out in accordance with the design, best practice and mitigation described in the report, significant effects on bats are not anticipated at the county, national and international scales. For further details please see the **Bat Survey Report** by MKO.

3.3 Part (c)

Aquatic Survey for all water courses within the site, due to the significance of Lough Inagh as an important salmonid lake and the hydrological connections between the site and European Sites

3.3.1 Response to Part (c)

Mayfly Ecology have prepared a **Biological & Chemical Monitoring of Surface Waters** report in response to Item 2(c). The report concludes that the results of the water chemistry and biological sampling paint a complicated picture across both properties, but it is clear there are pressures acting upon these water bodies including but not limited to; flow, pH and excessive metals.

Please refer to the submitted **Biological & Chemical Monitoring of Surface Waters** report enclosed in Appendix 3 for further details.

3.4 Part (d)

Mammal surveys (including any required mitigation during construction and in a post development scenario), including the use of trail cameras

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3.4.1 Response to Part (d)

As part of the multidisciplinary surveys conducted by MKO in July, August, and September of 2021 and October and November of 2022, searches for indications of badger, otter, and red squirrel were carried out. This search was conducted in order to determine the presence or absence of these species within Proposed Project site. In response to the RFI, targeted mammal surveys were carried out on the 20th and 21st of July 2023.

Additionally, trail cameras were deployed for a total of 14 days throughout the site. In addition to the above, incidental records of mammal signs were considered during the targeted bird and bat surveys, which were undertaken in response to the RFI. Multiple bird surveys were undertaken in May and July 2023. Bat surveys were undertaken on the 25th of May, 4th of July and 14th of August 2023.

Mammal surveys were carried out in line with NRA (2009) Guidelines on Ecological Surveying Techniques for Protected Flora and Fauna on National Road Schemes and NRA (2006): Guidelines for the Treatment of Badger Prior to the Construction of National Road Schemes.

No significant mammal activity was recorded within the footprint of the Proposed Project during the multispecies mammal walkover surveys undertaken. However, recordings from the trail cameras deployed throughout the site confirmed that the site is used by a range of mammal species including badger (Meles meles), otter (Lutra lutra), red squirrel (Sciurus vulgaris), fox (Vulpes vulpes), pine marten (Martes martes), and red deer (Cervus elaphus). Although no breeding sites for any species was recorded, taking a precautionary approach, mitigations have been provided, both in this mammal report and in the Biodiversity chapter of the submitted EIAR, to mitigate any potential pathways for effect on these species. Following the implementation of these mitigations, there is no potential for significant impact on any mammal species, as a result of the Proposed Project.

Otter

Best practice disturbance limitation measures.

- All construction plant and equipment to be used on-site will be modern equipment and will comply with the European Communities (Construction Plant and Equipment) (Permissible Noise Levels) Regulations 1998, and any subsequent amendments.
- Plant machinery will be turned off when not in use. Machines, which are used intermittently, will be shut down during those periods when they are not in use.
- Operating machinery will be restricted to the Proposed Project site boundary.
- It is expected that works will occur during normal working hours which will be agreed with the local authority in consultation with the appointed contractor prior to works commencing.
- Light spills during construction works will be minimised where possible thus reducing the effect on areas outside the Proposed Project, and consequently on fauna of conservation.

Red Squirrel

Habitat Loss/ Degradation
Following a precautionary approach, a pre-commencement red squirrel survey for each felling block will be carried in advance of felling, to identify whether any breeding red squirrel or dreys are located within that felling block. Surveys will be carried out as per NRA guidance (NRA, 2009, Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes. Dublin: National Roads Authority).

Should active dreys be identified within the felling block to be felled, the following mitigations and best practice procedures will be followed to ensure that no breeding red squirrel sites are impacted:

- Buffer zones of 50 meters will be established around the breeding sites during the breeding seasons (February to September inclusive).

Additionally, the following measures will be followed on a precautionary basis:

- As the proposed felling will result in a temporary reduction of food resources, supplementary feeding of red squirrel will be carried out.

Best practice disturbance limitation measures.
Same as for otter.

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Badger and pine marten

Habitat Loss/ Degradation
Following a precautionary approach, a pre-commencement badger and pine marten survey for each felling block will be carried in advance of felling, to identify whether any breeding badger and pine marten, and their associated habitats are located within that felling block. Surveys will be carried out as per NRA guidance (NRA, 2009, Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes. Dublin: National Roads Authority, and NRA, 2006, Guidelines for the Treatment of Badger Prior to the Construction of National Road Schemes. National Roads Authority).

Should active breeding sites for either species be identified within the felling block to be felled, the following mitigations and best practice procedures will be followed to ensure that no breeding badger or pine marten sites are impacted:

- Buffer zones of 50 meters will be established around the breeding sites during the breeding seasons.
- These exclusion zones will remain unfelled or will be managed as per guidance set out in the Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes (NRA 2006).

Best practice disturbance limitation measures.
Same as for otter.

Please refer to the submitted **Mammal Survey Report** prepared by MKO for further details.

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3.5 Part (e)

Full detailed explanation of the recreational use of the existing site and proposed use during operation and post-completion stages, any trails, locations of trails within and adjoining the site, use of fishing facilities at Lough Derryclare and Lough Inagh, this should include any required mitigation measures to protect the proposed bog landscape from humans, animals and any identified protected habitats/ species. (This should also be updated in the EIAR).

3.5.1 Response to Part (e)

The recreational use of the site will not be increased. The proposed development does not set out to increase recreational use of the area in any manner. The surveys completed as part of the initial planning application were based on the existing level of use on the site. The management of recreation use is detailed on the document "Derryclare management and maintenance plan, in section 4.0 under the title "General maintenance plan (including public usage)". In the interest of health and safety, public access to certain forestry blocks will be temporarily restricted during felling operations in keeping with Coillte's open-forest policy.

Please refer to Appendix 4 **Derryclare Management and Maintenance Plan** for further details.

Existing access will be maintained for existing users in line with the Coillte open forest policy.

There are no plans to change the current recreational use of the site. Coillte operate an open forest policy, and this will remain in place for Derryclare. The site is used informally for recreation under Coillte's open forest policy. Currently, there are no waymarked trails within the site, but the forestry tracks are used by walkers, as well as hikers accessing the 12 Bens. However, as set out in section 4.5.4 and 4.5.5 of the EIAR, the existing arrangements will be upgraded, including upgrading the existing car park, providing better threshold signage and maintaining the surface dressing on the existing forest roadways.

Section 4.5.4 of the submitted EIAR states *"It is proposed to upgrade the surface dressing of the existing carpark to provide a level, compacted car park surface. It is not intended to delineate individual car parking spaces. The car park will act as a landing point or trailhead for recreation and amenity users arriving at the site. The car park will provide a safe and easily accessible landing point, allowing visitors to orientate themselves on the site or demount bicycles from cars".*

Section 4.5.5 of the submitted EIAR states *"Entry point signage will be provided, at the main site entrance where recreation users can enter the site. The entry point information boards will provide information about the Wild Western Peatlands project and the peatland restoration process. The signage will also indicate the principles of 'Leave No Trace'. Information in relation to the flora and fauna present at the site and within the local area will also be provided".*

Section 4.5.3.1 of the submitted EIAR states *"Upgrading of the existing roadways will involve the laying of a new surface dressing on the existing section of roadway only where necessary".*

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4. FURTHER INFORMATION ITEM NO. 3

Based on the information submitted in the Environmental Impact Assessment Report and as identified in the Environmental Impact Assessment carried out by the Planning Authority, it is considered that the EIAR submitted has not presented a sufficient level of information and assessment in relation to impacts on Population and Human health, Biodiversity (with particular attention to Habitats and Birds Directives), Land, soil, water (in particular the risks of peat instability and impact on water quality), air and climate, Material assets, cultural heritage and the landscape, and the interaction between the above, for the competent authority to make an EIA determination that there is an acceptably low likelihood of environmental effects of a magnitude which would have a significant effect on sensitive environmental receptors as a result of the proposed development and mitigation proposed as part of the submitted EIAR. Therefore, the applicant is requested to address the following deficiencies within the submitted document:

4.1 Part (a)

The Irish Peat Conservation Council (IPCC) raised concerns within their initial scoping response regarding the adequacy of current "best practice approaches" to assessing peat strength and stability, these have been found wanting, owing to numerous landslides across the country. This in combination with the concerns raised by the DHLGH regarding using untrialled and untested methods of peat restoration in an upland area of the west of Ireland; the applicant is requested to provide sufficient supporting evidence demonstrating the trialing and testing of the proposed methods, including the provision of likewise case studies, providing the Local Authority with robust scientific evidence that the proposed methodologies of drain blocking, damning, drain reprofiling, stump flipping, surface smoothing, stump mulching and cross-tracking and do not pose detrimental risks of peat disturbance, peat erosion, peat stability and water quality impacts as a direct result of the development. The supporting evidence should be comprehensive and include the appropriateness of the proposed drain blocking using dams on slopes of greater than 6 degrees, the project proposes these works on slopes of 10 degrees which is contrary to current recommendations and untested in Ireland. Please comprehensively address this concern.

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4.1.1 Response to Part (a)

Please note that the information contained within the response to Item 3(a) should be read in conjunction with the EIAR as previously submitted with the planning application.

Fehily Timony have prepared a **Technical Note in Response to Further Information Required** enclosed with the FI response with regard to peatland rehabilitation. This note should be read in conjunction with submitted Geotechnical & Peat Stability Assessment as submitted with the planning application.

At the request of the NPWS, Fehily Timony conducted further site reconnaissance to include additional peat probe locations, and design and implementation of a Ground Penetrating Radar (GPR) survey at key profile locations across the site. The results of these surveys were analysed by Fehily Timony and the results are provided in an **Addendum to Geotechnical & Peat Stability Assessment Report** which is submitted with the FI response.

Fehily Timony undertook the peat analyses following the principles outlined in *The Peat Landslide Hazard and Risk Assessment Guide (2nd edition, PLHRAG, 2017)*. Determination of peat depths, strengths and resulting Factor of Safety (FoS) analyses were undertaken in accordance with Eurocode 7 guidance. These are current best practice guidance for assessment of peat strength and stability and have been used on upland peat sites across Ireland.

The methodology adopted for the assessment of peat stability and risk assessment is outlined in Appendix D of the submitted Assessment Report. In this approach, the main factors for assessing peat stability include the following:

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- Geomorphological
- Qualitative (judgement)
- Index/Probabilistic (probability)
- Deterministic (factor of safety)

In addition to the above and to ensure a robust assessment, the most conservative material parameters, site conditions and slope analysis method were used to assess the sites' peat strength and stability. These include the use of:

- **Conservative peat strengths** – as discussed in Section 6.1 of the Assessment Report, these values were derived from review of published information on peat strengths, resulting in the most conservative values being used for the stability analyses. Hand Shear Vane measurements within the peat were also undertaken as part of the site reconnaissance for verification purposes. In general, results from HSV testing were in excess of the conservative undrained shear strength values used in the stability analyses.
- **A 100% water level** – For the purposes of the stability analyses it was assumed that groundwater was at the surface. However, a 100% water level is an unlikely scenario due to overriding site conditions including prolonged dry weather conditions, i.e., sloping terrain and the abundance of natural drainage channels (as discussed in Section 4.2 of the Assessment Report).
- **Infinite slope analysis method** – the translational or infinite slope analysis method was adopted to assess the sites slope stability. This method does not consider resisting forces (such as toe loading or buttresses) and is therefore considered to be a conservative method for assessing peat slopes.
- **Surcharge from forestry machinery** – a surcharge of 10kPa was incorporated into the stability analyses to simulate the temporary load created by forestry machinery.

Considering all of the above, it is deemed that the best practice approaches and methodologies used in the Assessment Report erring on the side of caution, are more than adequate to determine the site's peat strength and stability.

Please refer to the **Technical Note in Response to Further Information Required** prepared by Fehily Timony for further details.

Following consultation with MKO and Coillte, a second phase of site reconnaissance was undertaken by FT. The purpose of the site reconnaissance was to further constrain the findings of the Assessment Report. The findings of the Phase 2 Reconnaissance are presented in the **Addendum to Geotechnical & Peat Stability Assessment Report.**

A site walkover was undertaken by FT over four days between 31st October and 3rd November 2023. Weather conditions during the site walkover were cloudy to overcast with periods of heavy rainfall and strong gusts. With respect to site characterisation, the findings from the Phase 2 reconnaissance highlighted no additional factors that could potentially contribute towards instability within the peat deposits. The main findings from the site walkover are summarised as follows:

1. In total, 77 no. additional peat probe locations were visited. The distribution of the combined Phase 1, Phase 2 and RPS probe locations are presented in Drawing No. 001.
2. Peat depths range from 0.0 to 6.3m bgl (PP087) with mean and median depths of 1.0 and 0.60m bgl respectively. The peat depths from both the Phase 1, Phase 2 and RPS surveys are presented in Drawing No. 002. The deepest peat deposits were almost exclusively found in areas of flatter terrain within the north, northeastern and southmost portions of the site.

3. Base of peat was typically recorded as bedrock. However, granular till and scree deposits were also noted. Profiles showing these geological sequences could often be observed in road cuttings and stream sections (Plates 1 and 2). No fine-grained material was encountered.
4. The sites' topography typically displays an angular and hummocky relief, frequently punctuated by bedrock outcrops. This type of morphology is indicative of shallow bedrock.
5. Buoyant peat was recorded at six peat probe locations (PP087, PP088, PP093, PP094, PP095, PP097) where peat depths range from 1.6 (PP095) to 6.3m bgl (PP087).
6. Localised areas of ponded water were recorded. This is not unexpected given the ground conditions and the flat terrain present in localised areas across the site.
7. Slope angles across the site range from 2 to 30 degrees with a mean and median value of 10 and 7 degrees respectively. The slope angle was obtained on site using a handheld Silva Clino Master, which has an accuracy of +/- 0.25 degrees. The slope angle quoted typically reflects the representative slope at each of the peat probe locations.
8. The undrained shear strength of the peat was determined in-situ using a Geonor H-60 Hand-Field Vane Tester. Undrained shear strengths ranged from 5 to 53kPa with a mean and median value of 17 and 15kPa respectively.
9. Other than the historic peat failure identified during the Phase 1 survey at probe location POI008, no other evidence of historic or recent peat instability was recorded.

The findings of the geophysical report are summarised as follows:

- There is a strong correlation between peat depths derived from the GPR survey with those taken during the Phase 1, Phase 2 and RPS peat probe surveys.
- In total, 116 areas of peat were identified, ranging in length from 150m in length) are exclusively found in areas of flatter topography. 41 no. of these areas were described as "pods" having lengths of <20m and often displaying a "bowl" morphology. These "pods" were not assessed for peat thickness and base of peat slope as the risk of instability was deemed to be negligible. The remaining 75 no. areas were assessed for peat thickness and base of peat slope.
- A total of 115 no. peat depths and associated surface and base of peat slope angles were recorded by MGL.
- Peat depths range from 0.8 to 5.0m bgl with an average peat depth of 2.38m bgl
- Peat occurs in isolated areas rather than large laterally continuous deposits.
- In general, the steeper areas of the site show limited extents of peat.
- Base of peat slopes follow the undulating and often rough surface of the underlying geology (typically bedrock).
- Base of peat slope angles broadly correlate with surface slope angles and are on average 2.5 degrees steeper. Localised steeper base of peat slopes are recorded; these predominantly occur over short distances (typically <20m) along the flanks of bedrock ridges. The base of peat slope angles were used in the peat stability assessment analyses for all GPR peat depth locations.

A number of "exclusion zones" are identified in Drawing Numbers 004 and 005 of the Addendum to Geotechnical & Peat Stability Assessment Report (Fehily Timony 2024). Within these exclusion zones the use of heavy machinery for restoration purposes shall be restricted.

4.2 Part (b)

The applicant should have monitored the water quality within and connected to the site in more detail to ascertain baseline quality information to inform both the EIAR and in the assessment of risk in relation to the Appropriate Assessment. Baseline data should be collected over an appropriately representative period, combining both manual and automatic monitoring triggered by flow and submitted in support of the application.

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4.2.1 Response to Part (b)

MKO issued a letter to the Environmental Department of Galway County Council. The letter lodged an official request to increase the frequency of chemical sampling in Derryclare Lough, Co. Galway in support and to address Item 3(b) of the request for further information on behalf of the applicant, Coillte Teoranta. The letter was acknowledged on receipt but no response has been received.

There will be 1 year of baseline water sampling in place on site as well as monthly samples taken during the restoration period.

Mayfly Ecology was commissioned by Coillte to undertake a programme of annual biological monitoring (macroinvertebrates – kick sampling) of surface waters at 4 suitable locations in Derryclare and this commenced in June 2023. A programme of monthly grab water sampling for chemical analysis commenced in October 2022 at 5 locations in Derryclare. Water sampling was undertaken by Coillte and laboratory analysis by Fitz Scientific measuring a total of 20 parameters. Mayfly Ecology was also commissioned to analyse the results of the chemical analysis on an ongoing basis.

The **Biological & Chemical Monitoring of Surface Waters** report enclosed in Appendix 2 prepared by Mayfly Ecology for Derryclare, which is submitted with this FI response, summarises the results of the biological and chemical results. In June 2023, biological monitoring occurred at 4 locations on site, and a review occurred of the further 5 locations on site where monthly chemical samples were taken as part of the baseline monitoring.

The report concludes that the results of the water chemistry and biological sampling paint a complicated picture across both properties, but it is clear there are pressures acting upon these water bodies including but not limited to; flow, pH and excessive metals. Two live monitoring stations will be installed for the duration of the project (and 16 pezimeters) to provide continuous monitoring throughout the lifetime of the project.

Please refer to the submitted **Biological & Chemical Monitoring of Surface Waters report** for further details.

4.3 Part (c)

It is noted that the rainfall data utilised to demonstrate the pluvial impact of water drainage across the site relies on data from a monitoring station in Claremorris and data collated from Met Eireann from 1965-1985, where the extents of extreme rainfall as a result of climate change would not have been recorded. This information gap alongside the relatively high levels of existing peat saturation combined with the proposed drain blocking, removal of trees & exposure of bare peat needs to be adequately analysed and studied to determine the risks posed and mitigation required to protect peat stability onsite and avoid any resultant impact on Population and Human health, biodiversity, land, soil and water quality as well as in the adjoining SAC. The applicant is requested to provide site specific standard rainfall data from recent monitoring carried out over an appropriate period across the application site, this should collate alongside the peat depths, saturation levels in corresponding months and results of the FRA. (requested on item d)

4.3.1 Response to Part (c)

Hydro Environmental Services (HES) have provided a response to this item within the submitted **Geological, Hydrological & Hydrogeological Responses to Submissions** document enclosed in Appendix 5. Item 3(c) is responded to as follows:

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Rainfall Data

The RFI suggests that the rainfall utilised in the EIAR chapter was from a monitoring station in Claremorris and relied on data collated from Met Eireann from 1965 to 1985. This statement is incorrect.

The data from Claremorris weather station was utilised solely with respect to average potential evapotranspiration. Average potential evapotranspiration data is only available for 14 no. weather stations in the Republic of Ireland. Whilst we acknowledge that this weather station is located ~54km northeast of the project site, it is the closest weather station for which evapotranspiration data is available. As stated in Section 9.3.2, the annual potential evapotranspiration at Claremorris is 408mm/yr. Other weather stations on the Atlantic Coast for which potential evapotranspiration data is available include Belmullet and Shannon Airport, located ~80km northwest and ~100km to the southeast of the project site respectively. The annual potential evapotranspiration at these locations is 527mm/yr and 543mmm/yr. Despite the differences in potential evapotranspiration between these 3 no. rainfall stations, the data from Claremorris is chosen due its proximity to the project site.

With respect to the rainfall data presented in Section 9.3.2 of the EIAR, the rainfall data was sourced from the nearest available rainfall station, *i.e.* Ballynahinch rainfall station, located ~7km to the southwest of the project site. We recognise that Ballynahinch station closed in 1985. However, Met Éireann have modelled the 30-year average rainfall for this station for the period from 1981 to 2010 (www.met.ie). The 30-year annual average rainfall for the period from 1981 to 2010 for Ballynahinch rainfall station was utilised in the assessment of runoff and pluvial effects associated with the Proposed Project.

In addition, Section 9.3.2 of the EIAR presents rainfall return periods for the project site. Rainfall return periods were sourced from Met Éireann (www.met.ie) which uses a depth duration frequency model to estimate point rainfall frequencies for a range of durations for any location in Ireland. Site-specific rainfall return periods specific to the project site are presented in the EIAR.

Nevertheless, we also recognise that the standard average annual rainfall (SAAR) of 1,211mm/yr referenced in the EIAR underestimates the actual rainfall at the project site. Met Éireann now provide a grid of SAAR for the entire country for the period of 1991 to 2020. Based on these site-specific modelled rainfall values, the SAAR at the project site ranges from 2,283 to 2,489mm/year, with an average of 2,429mm/yr.

An updated water balance is provided below, assuming an average annual rainfall of 2,429mm/yr.

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$$\text{Effective rainfall (ER)} = \text{SAAR} - \text{AE}$$

$$= 2{,}429\text{mm/yr} - 387\text{mm/yr}$$

$$\text{ER} = 2{,}042\text{mm/yr}$$

Groundwater recharge coefficient estimates from the GSI (www.gsi.ie) vary across the project site from 4% where the project site is overlain by peat to 85% where bedrock outcrop is present. Due to the extensive coverage of blanket peat at the site, the low permeability of the bedrock aquifers and the sloping nature of the topography, a recharge coefficient of 10% is taken for the project site. Based on this coefficient, an estimate of 204.2mm/year average annual recharge is given for the project site. This means that the hydrology of the project site is characterised by very high surface water runoff rates and very low groundwater recharge rates. Therefore, conservative annual recharge and runoff rates for the project site are estimated to be 204.2mm/yr and 1837.8mm/yr respectively.

SAAR and Implications for Peat Stability Assessment

The rainfall depths referenced in Chapter 9 of the EIAR has no direct implications for the Peat Stability Risk Assessment (PSRA) completed for the Proposed Project. The completed PSRA does not use standard annual average rainfall (SAAR) as an input parameter in the peat stability calculations. The

slope stability calculations are completed assuming a fully saturated peat profile (i.e. the water table is conservatively assumed to be at ground level), and a surcharge of 10kPa (*i.e.* an additional surface load) is applied to each analysis point. This surcharge is equivalent to 1m of stored peat or 1m of water (simulated) above ground level (given the similar density of peat and water). Therefore, the peat stability risk assessment accounts for additional water load (from seasonal and temporal rainfall events) in this manner, and not directly by use of the SAAR rainfall value for the site.

4.4 Part (d)

The application site including post operational needs to be fully assessed against the increased flood risk posed by the change of use of the land, including the changes to the management of the existing water courses and drainage flows within the application site. The FRA should examine the additional loading to the existing surface water features within the site, the ability of each harvest block to accommodate the predicted rainfall, including saturation rates of the peat, the structural capacity of the proposed dams (at the various locations) to accommodate predicted extreme pluvial events, as well as assessing the adequacy of the proposed silt traps and fencing and any additional mitigation measures which may be required.

4.4.1 Response to Part (d)

Hydro Environmental Services (HES) have provided a response to this item within the submitted **Geological, Hydrological & Hydrogeological Responses to Submissions** document enclosed in Appendix 5. Item 3(d) is responded to as follows:

Flood Risk

The purpose of the Proposed Project is to restore and rehabilitate the project site to Atlantic Bog and heathland habitats.

The project site was planted with coniferous forestry plantations in the 1960s. In order to facilitate the forestry operations at this time, the site was drained by inserting forestry drains, typically mound and ribbon drains, into the peat surface at regular intervals. The effect of this "draining" was that the water table in the peat bog was lowered, with water making its way into the forestry drains which in turn discharged into local watercourses and into Lough Inagh and Derryclare Lough. Following the change in land use at Derryclare to forestry, the Derryclare site retained less water than in its original undrained "natural" state. Furthermore, due to the current imposed forestry drainage system the local watercourses (*i.e.* mountain streams) almost certainly respond more rapidly to rainfall events and almost certainly have flashier hydrographs than would normally occurr in its natural state.

With respect to the hydrological and hydrogeological environment, the overall aim of the Proposed Project is to restore the hydrological regime prior to afforestation as much as practicable to its original state. Restoration and rehabilitation will place the existing peatland environments on a path towards naturally functioning peatlands.

Improvements in runoff volumes can be achieved through rehabilitation and restoration. The plans involve the rewetting of the drained peatlands (by increasing the saturation rates of the peat) through restoration works such as drain blocking, surface smoothing and re-profiling. These works will reduce surface water runoff from each harvest block, and on a wider scale increase the water storage capacity of the overall site. This will result in the hydrograph of nearby watercourses being less flashy, with a more gradual response to rainfall events. Therefore, these measures will reduce and delay the hydrograph peak on each of the local watercourses, and also reduce the flood risk downstream of the site.

Furthermore, irrespective of the volumes of runoff from the project site, all runoff from the site enters either Lough Inagh or Derryclare Lough. These are a series of large, interlinked lakes, and they have a

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huge ability to buffer rainfall runoff. As a result, the potential for an increase in downstream flood risk as a result of the proposed project is negligible.

Structural Capacity of Dams

As detailed in Chapter 4 of the submitted EIAR, the slopes and sizes of the drains will be the deciding factors in selecting the dam material types and also the spacing of the dams. The selection of dam materials will be based on the existing best practice bog restoration techniques and guidelines. Peat dams will only be used on shallow slopes (<6° gradient), with plastic dams being used on steeper slopes. The spacing of dams will also improve the structural capacity of the dam by decreasing the loading of individual dams. The dam spacing will be between 7.5 m and 20 m on flatter ground, however, the frequency of dams will increase to between 5 m and 7 m on steeper sloping ground.

Best practice for dams is outlined in the submitted Forest to Bog best practice document included in Appendix 6 of this report and will be followed for this project.

The construction of dams and the materials used will be based on best practice bog restoration techniques and guidelines. This includes restricting all dam construction to shallow slopes (<6° gradient). On the steeper gradients other techniques will be used such as complete infilling of drains, reprofiling or windrowing. To ensure the best and most appropriate restoration technique is selected, that best suits the site conditions, a decision support tool was developed (see Appendix 1). This tool sets the operational parameters for each restoration technique using 5 key site factors, namely peat stability factor of safety, slope, peat depth, soil type (blanket bog or heath) and stump size. As slope is a key input, this tool ensures that all dams will be installed in appropriate, specified locations across the site.

Adequacy of Silt Traps and Silt Fencing

As detailed in the EIAR, silt fences and silt traps will be installed at the outfalls of existing drains before the commencement of any works. In areas that are particularly susceptible to erosion (*i.e.* steeper slopes), it may be required to install double or triple silt fences. These measures follow all existing best practices and guidelines in relation to felling and bog restoration and will ensure the protection of downstream surface water quality.

With respect to the adequacy of these features, silt traps and silt fences are widely used during peatland restoration for the prevention of suspended solids entrainment in runoff. Silt traps/fences are incorporated into the Construction Phase for water quality protection only, and they serve no function in long term water attenuation within the Rehabilitation Plan. During the Construction Phase silt traps/fences will be regularly inspected to ensure that they are functional and turbidity will be measured downgradient of the works areas. Necessary repairs and maintenance will be completed when required following inspections. In the event that elevated turbidity concentrations are recorded downstream, all upstream silt traps and silt fences will be inspected and no additional works will be completed until necessary repairs are made and downstream turbidity concentrations return to baseline levels.

Furthermore, the restoration plan also includes an extensive plan to install an intensive network of new protective buffer zones along all watercourses and the lakes (see restoration maps in the enclosed **FI Drawing Booklet**). These buffer zones will vary in width from 30 to 40m and these will be the most effective and permanent silt control measure.

No additional mitigation measures are deemed necessary.

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4.5 Part (e)

The inhouse nature of site selection (other stakeholders are not listed) is limited. Justification demonstrating the precautionary approach was applied to site selection criteria in light of the many challenges of the Derryclare site including high status rivers, surrounded by European Sites, important

salmonoid lake, steep topography and extensive variability in peat depth should be adequately demonstrated in the EIAR. Please address this concern also referring to alternative conservation and rewetting solutions including solutions on lower slopes.

4.5.1 Response to Part (e)

The site selection process was described within Section 2 of the submitted Planning Report prepared by MKO. The site selection process was comprehensive and thorough, looking at all of Coillte's sites which were suitable as restoration projects. Appendix 1 of the submitted Planning report Section 2 of the planning report states the following:

"The proposed Derryclare Wild Western Peatland Project is part of Coillte Nature's ongoing Wild Western Peatlands Project. The objective of the Wild Western Peatlands Project is to restore and rehabilitate approximately 2,100ha of Atlantic blanket bog and wet heath along the western seaboard of Ireland - that is currently planted with poorly performing inappropriate spruce and pine forests - to enhance biodiversity and improve carbon storage in the landscape. The area was planted to create rural employment at a time when the importance of peatlands for climate and biodiversity reasons was not well understood. The project presents an opportunity to restore a very rare and unique area of biodiversity".

The key objective of the WWP project is to restore and rehabilitate areas of Atlantic blanket bog and heathland that are currently planted with inappropriate lodgepole pine and Sitka spruce forests. The WWP project is funded by DAFM, as it recognises that some past afforestation on blanket peatlands has been inappropriate and not suitable for forestry. Today, forestry on unenclosed blanket bog is no longer regarded as sustainable and it is also no longer grant aided. Many of the existing forests on blanket bogs that were planted in the past would not be eligible for grant aid today. Many of these plantations are struggling to survive and are now recognised as inappropriate due to the loss of biodiversity, negative impact on water quality, net carbon and methane losses, negative impact on visual landscape and low timber production potential. These forests are both economically and environmentally unsustainable. The benefits of repurposing these forests far outweighs continuing with plantation forests under a clearfell rotation system. These state-owned afforested peatlands are currently the target of a number of important Government action plans, to which this project seeks to respond. The NPWS's Prioritised Action Framework for Ireland 2014-2020 gives an objective to implement "measures to better integrate modified forest landscapes with Natura 2000, with the aim of restoring extent and connectivity of Annex 1 habitats and habitats for species." The National Peatlands Strategy (2018) calls for the present management of state-owned peatland to be "evaluated and alternative management options aimed at increasing the delivery of all the ecosystem services of naturally functioning peatlands" to be considered, with special responsibility for Coillte to continue to "show leadership in responsible management, rehabilitation and restoration of peatlands". Furthermore, the National Biodiversity Action Plan (2017-2021) also calls for "maximised positive outcomes for biodiversity and ecosystem services and restoration of areas impacted by inappropriate forestry".

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Central to the Derryclare restoration plan is habitat restoration, where Coillte aim to continue the Forest to Bog restoration started over a decade ago under the EU LIFE programme. Environmental and social concerns are central to the restoration plan, and these have been extensively evaluated by consultant experts to ensure the plan is consistent with enhancing biodiversity, protecting water quality, enhancing the surrounding statutory designated areas, providing a wide range of ecosystem services, creating the conditions to facilitate the return to blanket bog, and ensuring that the visual landscape is improved in line with the iconic nature of the location.

Coillte has identified 30,000 ha of its estate as potentially suitable for Forest to Bog restoration. The initial site selection criteria for the WWP, outlined below, was applied to a range of sites on the Coillte estate. A scoring system (Table 1) was devised that allowed sites to be scored, evaluated, and shortlisted. Following this site selection, 5 sites were shortlisted (Figure 4). Please refer to Appendix 1 of the submitted Planning Report for further detail on the comprehensive process undertaken by Coillte

Teoranta when selecting the most appropriate site for the pilot project. The criteria included the following.

Criteria for Site Selection:

1. The key driver to site selection will be to optimise the biodiversity, water quality and climate mitigation attributes in areas impacted by inappropriate forestry. Priority will be given to sites containing blanket bog and heathland that are considered suitable for restoration on ecological grounds, with the aim of restoring extent and connectivity of Annex 1 habitats. Proximity and hydrological connection to SACs with blanket bog and wet heath habitats is a key attribute. The presence of associated Annex 2 designated floral and faunal species are also important criteria.
2. Blanket bog will be given priority especially sites where there is a significant proportion of deep peat >50cm to increase the delivery of all the ecosystem services of naturally functioning peatlands – rehabilitation and restoration of peatlands.
3. Enhance water quality protection particularly in areas with freshwater pearl mussel (FWPM), salmonid catchments and where forestry is a key pressure in high water quality catchments.
4. Local partnership potential with involvement of statutory and local stakeholders and community is an important factor in site selection.
5. Minimise release of carbon from peat soils and strive to maintain a positive carbon balance. Where the site is not a priority for restoration and is likely to support sufficient tree growth to compensate for greenhouse gas losses from the soil (understood to be YC8 or above for Sitka spruce), they will be retained as resilient environmental mixed woodlands.
6. Sites of low timber production capability, with the majority of conifers growing at yield class 12 or below will be targeted for removal and restored to bog and/or wet heath.
7. Poor landscape design and visual appeal of forest particularly in highly sensitive and scenic landscapes will be a consideration re site selection criteria.

Table 1: The scoring system used to rank sites for bog restoration.

Criteria	Score (1 low; 10 high)
Priority for Annex 1 blanket bog habitat restoration on ecological grounds (within or adjacent to SAC) and associated wet heath, typically <YC10. High proportion of deep peat >50cm depth. Current Bioclass score 1 or 2.	10
Hydrological connection to adjacent SAC with Annex 1 blanket bog and wet heath. Associated Annex 2 floral and faunal species	8
Water quality protection - Highly sensitive water catchment (FWPM Top 8 > FWPM, salmonid catchment, drinking water)	6
Local partnership potential	5
Maintain positive carbon balance (<YC8 SS or YC6 LP). Retaining plantations above YC10 (SS) to maintain positive carbon balance	5
Low timber production capabilities	3

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Landscape enhancement in sensitive and scenic landscapes	3
Total score	40

Figure 6: Wild Western Peatlands Project Shortlisted Sites (Source: Stakeholder Information Document)

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During the WPP site selection process, five different Coillte sites were shortlisted during the consultation process. Figure 4 shows the shortlisted selected sites. This information is also included in Appendix 1 of the submitted Planning Report. To evaluate the shortlisted sites, further considerations made concerning: a) the proportion of 1st rotation crops (where best practice suggest restoration is more successful on 1st rotation crops, as opposed 2nd rotation crops, b) local sensitivities (Derryclare Nature Reserve was adjacent and provided an opportunity to enhance this reserve) and c) the presence of any significant threats or risks such as invasive species, deer, grazing, legal constraints etc., and d) is the site representative of the Forest to bog sites on the Coillte estate. Following this evaluation, Derryclare was selected.

Peatland restoration is one of the primary nature-based solution to the biodiversity and climate crisis in Ireland, as blanket bogs accumulate and store carbon as well as possessing unique habitats with high biodiversity value. Internationally, the general consensus is that bog restoration should occur where possible. These peatlands also store and filter water, playing a vital role in the management of water

catchments. Careful management of these areas is therefore crucial for climate action. The Wild Western Peatlands Project has been informed by precedent bog restoration projects in Ireland, Northern Ireland and Scotland. In the past decade, Coillte have been to the forefront in bog restoration, having project managed a total of 1,988 ha and 571 ha of blanket and raised bog restoration respectively, under the EU LIFE programme. Coillte is ideally placed and experienced to deliver large Forest to bog restoration projects at scale, in line with governmental policy. Coillte's own policy is to restore 30,000 ha from Forest to bog by 2050. One of the objectives of participating in the EU LIFE projects was to gain experience and develop knowledge to facilitate subsequent restoration projects, all of which have been built into the Derryclare restoration plan. The principles of environmental impact assessment and risk management have been applied in the Derryclare plan and the potential interactions between restoration activities and standard receptors are comprehensively detailed in the EIAR.

If the proposed project were not to proceed, the current land-use, i.e., plantation conifer forestry, at the site will continue. The opportunity to restore and rehabilitate the site to blanket bog and wet heath would be lost, along with the opportunity to better align the landscape of the Proposed Development Site with the surrounding moorland landscape character.

We additionally wish to highlight that consultation was undertaken with external stakeholders including environmental NGOs, regulatory bodies, government agencies, community networks and local businesses. As detailed in Section 3.1 of the Planning Report submitted with the application, an online stakeholder event was held as well as numerous stakeholder site visits.

As mentioned above, Coillte has restored 2,559 ha of peatlands over the last decade and the experience gained and the best practices were included in the "Forest to bog" best practice guidelines developed for this project (see Appendix 6). This detailed report also compiles all know best practices used in Ireland and Scotland to identify the best restoration practices that can be used by practitioners. In developing this report, Coillte linked up with Forest and Land Scotland (FLS) in Scotland to evaluate their advancements made in bog restoration techniques, which they have been using, at scale, for almost a decade. These alternative conservation and rewetting solutions include site reprofiling, cross tracking and stump flipping. The evaluation included joint site visits in Scotland and Ireland and it provided a comprehensive review of the techniques, machine specifications, operational requirements and safeguards needed to adopt these new techniques. Forest and Land Scotland (FLS) together with NatureScot have documented these techniques on their websites for the wider peatland restoration community to view. In Ireland to date, large scale Forest to bog peatland restoration projects typically felled and removed the trees, windrowed the sites, and blocked the drains. Today, these sites have restored with mixed success, some restoring fully and others requiring follow up maintenance to remove reseeding conifers and invasives. In Scotland, the Forest and Land Scotland (FLS) alternative rewetting solutions are seen as an enhancement of known restoration techniques, that provide better and speedier restoration results, by been more successful in raising the water table and making the conditions less favourable for reseeding and invasives, and more favourable for the bogland species to colonise the site. The peatlands in Scotland are similar to Ireland and these promising new techniques should be trailed in Ireland in the Derryclare pilot site.

In developing the Derryclare restoration plan, it was decided to adopt the learnings from Forest and Land Scotland (FLS), and a site visit was held on site with Forest and Land Scotland (FLS) as these alternative conservation and rewetting solutions are new to Ireland, it was important to build in certain safeguards into the plan, especially concerning water quality and peat stability. This involved planning the entire site on the assumption that the most disruptive restoration method would be used across the entire site and proportional mitigations were then prescribed across the entire site. This ensures that all alternative conservation and rewetting solutions would be suitably mitigated. The full range of mitigations are included in the EIAR and CEMP, but they include for example, a detailed hydrological monitoring plan, including live monitoring during operations, applying a peat stability factor of safety, creation of buffer zones along all water courses and lakes of between 30 to 40m, identification of all active drainage from the entire site, and matching the prescribed restoration method to the site conditions.

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Matching the prescribed restoration method to the site conditions was an important consideration. This was achieved by developing the "Decision matrix". The decision matrix is a tool that can be used to select the restoration option most suited to the site, based on the site conditions. It also allows you to identify what restoration options are not suitable for the site. The decision matrix requires key site data, and it allows the user to prescribe restoration options appropriate for the underlying site conditions. These site conditions include the peat slide factor of safety, slope, peat depth, soil type (blanket bog or heath) and stump size. The decision matrix is a table that lists all the restoration options (21 permutations) in order of their expected ground disturbance, where option 1 is expected to have the least ground disturbance and option 21 the greatest. The restoration options are also listed in order of their expected speed of restoration, where more intensive restoration methods are assumed to produce speedier restoration (based on the best available literature). The purpose of the decision matrix is to find the restoration option that will cause the least disturbance and deliver the best restoration results and help guide the planner in selecting the best restoration option for the site. It is important to note that there are 21 possible restoration options, except for one option (17), which refers to scrap mounding, where the option is to replant with pioneer native woodland. Options 1 to 15 refer to the restoration options currently used in Ireland, and options 16 to 21 (excluding 17) refer to the Forest and Land Scotland (FLS) conservation and rewetting solutions. This evidence-based approach using site factors ensures that the restoration option selected matches the site conditions. In Derryclare, the decision matrix resulted in approximately 60% of the site been selected for the restoration options currently used in Ireland, and 40% selected for the newer Forest and Land Scotland (FLS) conservation and rewetting solutions (see restoration maps in the Further Information Drawing Booklet).

4.6 Part (f)

The submitted documentation makes no mention of Himalayan Balsalm in the invasive species report, nor are the areas of identified invasive species mapped including bush size and density across the application site, showing their proximity to watercourse and/or potential spreading by the proposed works in each harvest block/sub-unit.

4.6.1 Response to Part (f)

Invasive species can cover a range of plant species, however, in Derryclare, following a detailed ecological assessment (Ecological Report, Hunt, 2021), the main pressure from invasive species was identified to come from rhododendron ponticum. No other invasives (other than conifer reseeding) was observed. Two separate approaches were taken to assess the baseline infestation level, namely:

a. The ecologist walk-over survey, using the DAFOR scale.
b. Detailed sampling survey, using a 10m transect method.

During the ecological assessment of the site, the ecologist conducted a walk-over survey to identify the invasive species present and described the level of infestation, using the standard DAFOR scale (described below). This is a standard approach to assess the level of infestation of invasive species in a forestry setting. This method uses the existing forestry sub compartment boundaries and provides a generic textual description of the level of infestation based on walk over observations. The descriptions are D for Dominant, A for Abundant, F for Frequent, O for Occasional and R for Rare. This data was then used to produce a heat map, which gives a general estimation of the level of infestation over a wide area. This approach provides sufficient data to inform an operational plan to manage invasives. The results are presented in Figure 7 Map 1 below.

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The DAFOR scale

PRESENT used where Rhododendron is considered likely to be present but not sufficiently walked to rate following DAFOR as below:

D for Dominant: In practice you will rarely, if ever use this. To score **D**, a species would have to be the most common plant by far, in well over three quarters of the square. It is possible that in a square that is entirely conifer plantation, that Sitka spruce Picea sitchensis might score **D**; or in a square that is almost all occupied by highly improved grassland, perennial rye-grass Lolium perenne might sometimes score **D**, but even these two scenarios are unlikely most of the time. If you are not sure if something should score **D** or **A**, give it **A**.

A for Abundant: Only use **A** if the plant was really very common in many parts of the square. For most species this would mean that there were thousands of individual plants present. In most squares, few species will score as highly as **A** and in quite a few squares there will be no species that score that highly. If you are not sure if something should score **A** or **F**, give it **F**.

F for Frequent: Use **F** if you found the plant in several places in the square and there was usually more than just **A** few individuals in each of these places. You could also use **F** if the plant was only present in one part of the square but was very common in that part, with many individuals and covered **A** substantial area (e.g. between one eight and one quarter of the area of the whole square). If you are not sure if something should score **F** or **O**, give it **O**.

O for Occasional: Use **O** for species that occur in several places in the square, but whose populations are usually not very big. You would also use **O** for species that are very common in one bit of habitat within the square that occupied just a small area (e.g less than one eight of the area of the whole square). You will use **O** for many species in most squares. If you are not sure if something should score **O** or **R**, give it **R**.

R for Rare: Use **R** for any species that occur as a small number of individuals in the square. This small number of individuals may be located in one place in the square, or scattered over several different locations within the square. In many squares **R** is likely to be the score that most species get. If you are not sure if something should score **O** or **R**, give it **R**.

For those of you who are used to using the DAFOR scale, please stick to the basic 5 scores only and avoid entries like **O/F** (occasional to frequent) and particularly please avoid using the prefix 'L' as in **LF** (locally frequent).

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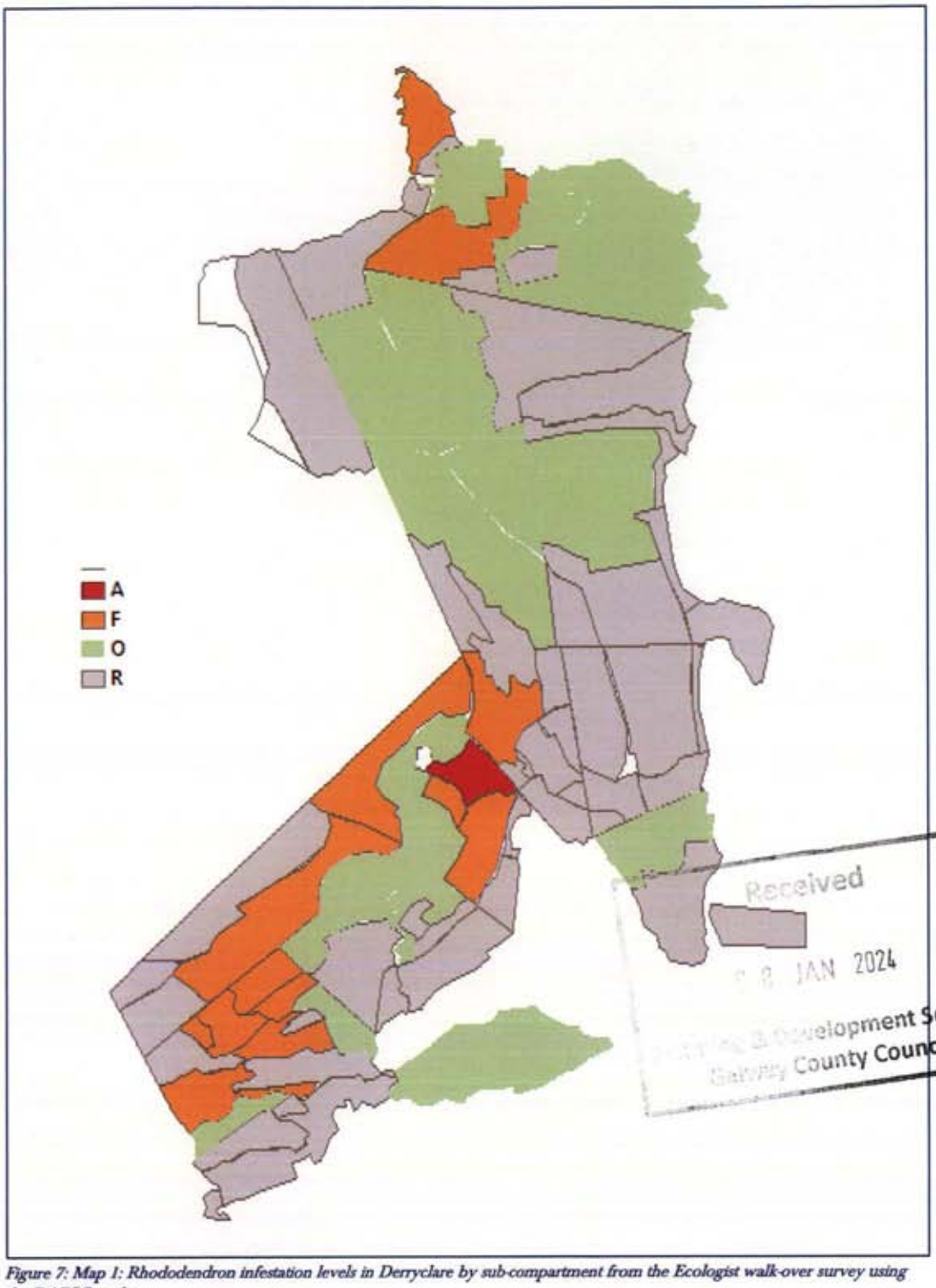

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Figure 7: Map 1: Rhododendron infestation levels in Derryclare by sub-compartment from the Ecologist walk-over survey using the DAFOR scale.

However, one limitation of the DAFOR method is that it does not provide the exact locations of the individual rhododendron plants and to provide this, a more detailed survey was undertaken. The intensive methodology used by the NPWS (under the Kerry LIFE project) was initially considered, and it was decided that this approach was too intensive and impractical to adopt in Derryclare. A sampling approach was decided as the best fit for Derryclare, as it addressed the limitations of the DAFOR method, and it was less intensive and more practical to implement than the method used in the Kerry

LIFE project. This sampling approach collected the essential detail required and ensured the process could be easily replicated in future years to monitor progress. As the decision was made for annual interventions on site, during the lifetime of the project, the sampling method was deemed to be the best fit. This sampling method is described here as the '10m transect method'. Please refer to Appendix 6 for observations made when using this sampling method.

The 10m transect method was adopted for Derryclare, to establish a baseline for future monitoring. The 10m transect method is a sampling method that involves a work gang walking a transect of 10m grids throughout the whole property and taking observations at each intersection point on the grid. In Derryclare, 3 people walked through the forest in a line 10m apart from each other. At every 10m intervals the line stopped, and an assessment was made on the level of infestation within a 5m radius from their location. All data was recorded, and geo referenced using GPS Trimble devises, using the ArcGIS Field Maps application. If no rhododendron was present, no data was collected. Where rhododendron was present, a point was recorded with a comment to describe the circumference of the bush(es) sizes (see Table 1). The walk over survey also encountered sub-compartments that were fully infested with rhododendron, and these were noted during the field work and added in as polygons on the baseline map. This field data was then mapped in ArcMap 10.6.1 to form the baseline level of rhododendron infestation in Derryclare (see Map 2).

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Table 2: Comments used in the ArcGIS Field maps app to describe the infestation.

Description	Explanation	Comment
Rhodo1	Bush size circumference 1m or less	Mostly seedlings (pre flowering)
Rhodo2	Bush size circumference 2m or less	Small bush(es)
Rhodo3	Bush size circumference 3m or less	Larger bush(es)
Rhodo4	Bush size circumference over 3m	Mature clumps

This sampling method has the following main advantages:

- It allows for a relatively quick and accurate field assessment to be made.
- the exact locations within +/- 5m are provided.
- it provides details on the different stages of maturity of the infestation.
- It can provide the exact locations and a more general heat map.

- It is practical and cost effective (3 weeks work for a gang of 3 people to cover 500 ha).
- The data can be used as the basis for an operational work plan.

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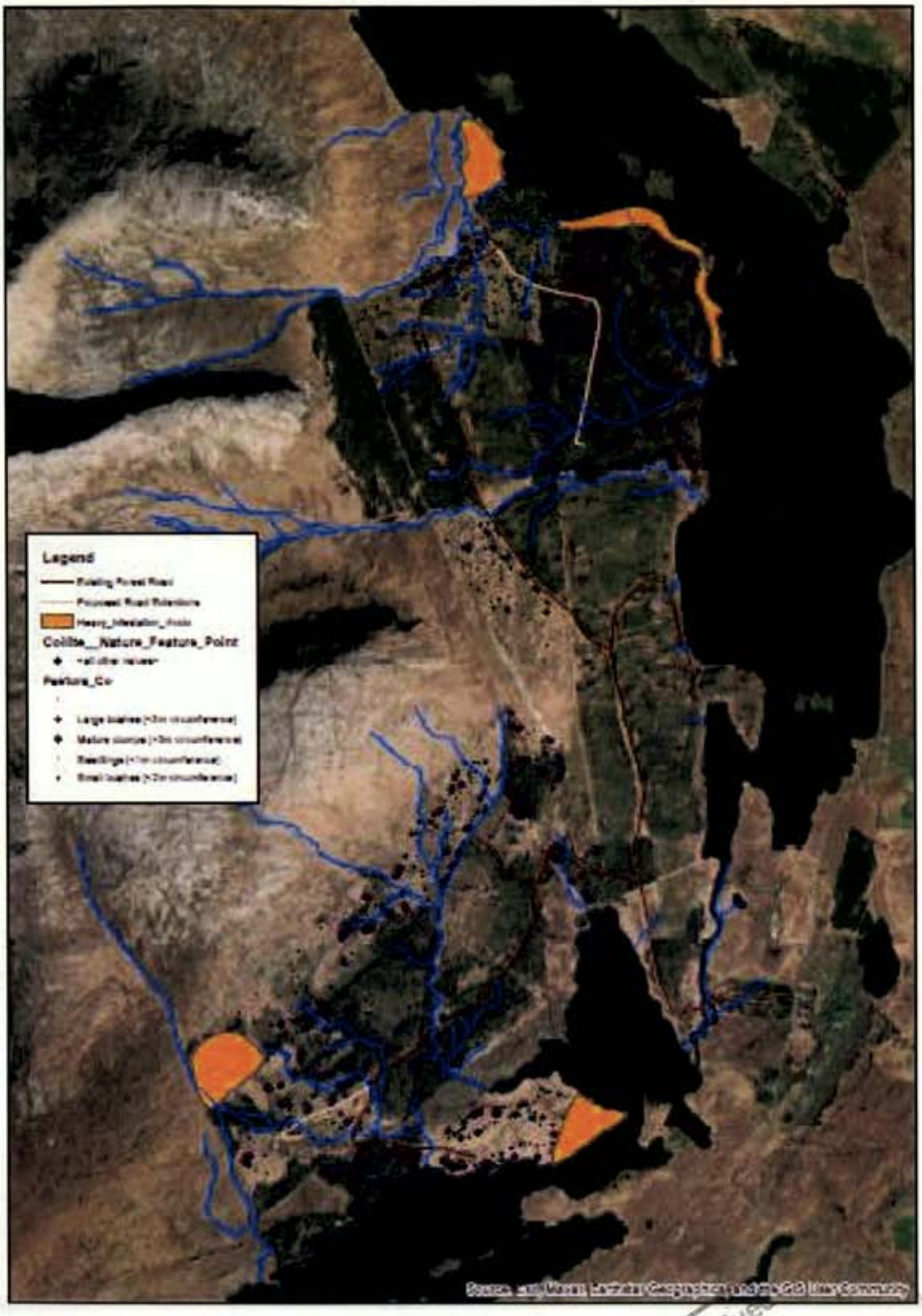

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Invasive species management plan

The baseline data was used to inform and develop the invasive species management plan summarised in Table 3 below. The baseline data collection has shown the level of rhododendron ponticum infestation to be widespread throughout the property, with a mixture of plant sizes and ages. Therefore, the main invasive species threat in Derryclare is from Rhododendron ponticum. There are many papers on rhododendron control (Higgins, (2008) Cross, (1973) Rotherham, (1983). Edwards, (2006)) and it is well understood. Their control is essential and often problematic and successful removal requires continual vigilance and many costly interventions. Regeneration of lodgepole pine seedings is also a known issue with peatland restoration in Ireland and it can be expected in Derryclare. This is typically associated with tree removal of mature crops with heavy cone production on sites that were ploughed. The cones of lodgepole pine and their seed can remain viable for many years, and regeneration on restored sites is most often found where the original plough ribbon is left intact, offering slightly drier conditions that favour seedling regeneration. According to Campbell et al., (2019) conifer regeneration can be dealt with by surface smoothing methods, but otherwise must be removed manually. In Scotland, it was observed that carrying out the restoration work immediately post felling and raising the water table as soon as possible, is an effective way to limit conifer and invasive species regeneration by creating unfavourable conditions for seeding germination. Where seedlings regenerate, the optimum time to remove them is when they are young enough to be pulled up out of the ground or cut with a garden lopper or equivalent. Allowing the seedlings to grow any older will require a chainsaw intervention.

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As restoration works proceed and ground disturbance increases, the latent potential for rhododendron infestation and conifer reseeding becomes even more significant. Therefore, owing to the scale of the area involved, an **annual property wide intervention is planned every year**, and this can be very effective as the restoration plan is staggered over several years. The methodology used will be the same one adopted by a recent NPWS study done in the adjoining forest in Kylemore. This approach works well in Connemara and is suited to a restoration programme that allows treated rhododendron plants to remain standing for a few years, before been felled to waste or windrowed. The methodology involves using a chainsaw to nick the stems of mature plants followed immediately with a spot spray of a dilute chemical. Allowing the plant to remain standing, allows the chemical to translocate through the whole plant, resulting is a higher kill rate. Owing to the multiple stems associated with rhododendron, some stems are likely to be missed, so a second, or even third pass is required each year to ensure the plant is fully killed. It is expected that repeating this every year will ensure that when it comes to felling the forest, the understory rhododendron will be dead, and it can be driven over and/or windrowed. This method also 'spot sprays' all the emerging seedlings, especially those in flower. Once the forest is felled and the restoration completed, either spot spraying, or preferably, hand removal of emerging seedlings can be undertaken, to deal with residual rhododendron. The aim is to ensure all restored areas are entirely free from rhododendron and monitoring of these areas will provide a quick visual guide regarding the progress of the rhododendron treatment programme.

It is also noted that the source of seed for rhododendron infestation is off-site on adjacent private property. Treating the rhododendron on private lands is outside the scope of this project. However, this situation will be monitored and if an opportunity arises, co-operation will be offered to assist with rhododendron removal on adjacent private lands. Consequently, within Derryclare property, rhododendron will need to be continuously managed.

Management of conifer reseeding will occur alongside the management plan for rhododendron. In this case each restored site will be monitored for all seedling regeneration and the regeneration removed as part of the annual property wide rhododendron work. Managing it this way will ensure that the issue is addressed each year as reseeded plants are easily managed when small.

The plan to manage Rhododendron ponticum and conifer seedling regeneration in Derryclare involves the following.

1. Establish the baseline level of infestation of rhododendron ponticum.
2. Schedule annual property wide interventions during the lifetime of the project.
3. Monitor progress.
4. Use local community groups for field work.

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An overview of the planned treatment schedule for managing rhododendron and conifer reseeding is detailed in Table 3 below.

Table 3: The planned schedule for managing rhododendron in the Derryclare bog restoration programme.

Year	Bog restoration schedule	Rhododendron treatment
0	Secure planning permission and felling licences.	• Property wide treatment of all mature rhododendron plants and seedlings in flower.
1	Year 1 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Monitor emerging seedlings from recently restored areas.
2	Year 2 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower • Pull/threat emerging seedlings from recently felled areas. • Monitor emerging seedlings from recently restored areas.
3	Year 3 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from year 1 & 2 felled areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline.
4 to 7	Year 4 to 7 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas.

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		• Monitor emerging seedlings from recently restored
8	Year 8 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline. • Post year 8, monitor site every 3 years and carry out works, if required.

Please see enclosed Appendix 7 **Invasive Species Management Plan Observations** for further details.

4.7 Part (g)

There is an absence of detail in relation to the assessment of potential operational stage impacts from invasive species, re-seeding conifers and grazing animals, public usage and any proposed management to deal with these factors.

4.7.1 Response to Part (g)

The operational detail planned for Derryclare is provided below.

These plans deal with ongoing management and general maintenance issues that will be managed over the entirety of the project implementation stage. This plan covers 5 key areas, namely,

- Invasive species management plan
- Hydrological monitoring
- Grazing management plan (including deer management).
- Fire plan.
- General maintenance plan (including public usage).

Invasive species management plan

Invasive species can cover a range of plant species, however, in Derryclare, following a detailed ecological assessment, the main pressure from invasive species was identified to come from rhododendron ponticum and conifer reseeding with mainly lodgepole pine. Regeneration of lodgepole pine seedings is also a known issue with peatland restoration in Ireland and it must also be managed. The operational plan to deal with invasives involves annual interventions over the lifetime of the project and it is described fully in Section 3.6.1 above.

Hydrological monitoring

There is a detailed and robust hydrological plan that will monitor surface water flow volumes, water table depths and surface water quality monitoring using a variety of techniques, including, automatic sondes, monthly grab sampling, operational water sampling, annual biological monitoring, water level flumes and turbidity monitoring.

Grazing management plan (including deer management)

Grazing pressures from mainly sheep, livestock and deer can lead to dominance by Molinia caerulea and Eriophorum vaginatum (Shaw & Wheeler, 1994) with a decline in Sphagnum species (Lindsay, 2010). The main grazing pressure in Derryclare is from sheep, deer and occasionally cattle. Browsing by hares is also an issue especially regarding woodland development and planned new pioneer woodland establishment. The plan to deal with this is described below.

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Fire plan

Fires on blanket bogs tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. After infrequent fire events there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return where burning results in a bare peat surface (Evans & Warburton, 2007). Derryclare is an area historically at risk from wildfires and as a result, this pressure must be managed. The plan to deal with this described below.

General maintenance plan (including public usage)

General maintenance is a catch all that refers to addressing issues as they arise and they can include a wide variety of tasks such as road maintenance, silt trap and dam inspections and repairs, dumping, vandalism, signage erection and repair, and dealing with the public and local requests arising from consultations. For Derryclare the most important general maintenance is expected to be silt trap and dam inspections and maintenance, keeping the main access road in good repair and issues with the public such as recreational usage, dumping and vandalism. The plan to deal with this described below.

Grazing management plan (including deer management)

Summary

The grazing pressure in Derryclare arises from livestock (mostly sheep) and deer. The maintenance plan initially involves the construction of an external sheep fence to ensure that the entire property is fenced off and secured. All livestock will be removed before the fence is completed. An internal deer fence will be erected to fence off the area where pioneer native woodland will be established. Browsing by hares on broadleaves will be monitored and tubes used if browsing is observed. The site will be monitored for trespass and appropriate action taken where required, up to and including impounding. Regular checks will be made to the fence-lines to ensure they remain intact, and any breaches or faults will be repaired as a matter of urgency. Coillte have a process for impounding livestock and this process will be followed if required. Deer culling will not be used in the grazing maintenance plan as Coillte do not own the shooting rights on site. Any deer culling will only occur in agreement with the relevant stakeholders and within the law. To date, there are no immediate plans to carry out any deer culls. However, in the event that it is possible to secure agreement with the adjacent landowners and Sporting rights owner, then culling will occur.

Table 4: The grazing management plan by year during the restoration works.

Years	Restoration plan	Grazing plan
0 (2023)	Secure planning permission and felling licences.	• Complete external sheep fence on external boundary. • Exclude livestock from all site. • Monitor all site for trespass.

1 (2024)	Bog restoration site.	• Check sheep fence line. • Monitor all site for trespass.
2 (2025)	Pioneer native woodland sites.	• Erect deer fence stage 1. • Check sheep fence line. • Monitor all site for trespass and browsing.
3 (2026)	Pioneer native woodland sites.	• Erect deer fence stage 2. • Check sheep fence line. • Monitor all site for trespass and browsing.
4 to 8	Bog restoration sites.	• Check deer fence line. • Check sheep fence line. • Monitor all site for trespass.

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General maintenance plan (including public usage)

Summary of the plan

General maintenance is a catch all that refers to addressing outstanding issues, other than invasive species, deer and livestock grazing, and fire, which are all detailed separately. General maintenance on this plan includes a wide variety of tasks such as road maintenance, silt trap and dam inspections and repairs, public usage, dumping, vandalism, erection, and repair of signage, dealing with the public and local requests arising from consultations. For Derryclare the most important general maintenance is expected to be silt trap and dam inspections and maintenance, keeping the main access road in good repair and dealing with issues with the general public such as dumping and vandalism.

General maintenance typically falls under the following headings, public usage/recreation, forest roads, operational maintenance, and anti-social activity. Regarding public usage/recreation, Coillte have an open forest policy which allows permissive access on foot to individual walkers. Across the Coillte estate an estimated 18 million visits to Coillte forests occur every year. This policy will remain in place for Derryclare. Currently, access is obtained by parking at the main entrance and entering the site on foot. This will not change during project duration, though public access to works areas will be restricted during forestry operations in the interests of health and safety. This is inline with current Coillte policy. Public usage will be welcomed and facilitated with better car parking facilities at the main entrance and better signage. The forest roads are essential for site access for both operations and the general public. The forest roads will be maintained during operations. Operational maintenance during the restoration works refers to maintaining the restoration works and ensuring they remain effective. This includes silt traps, constructed dams, leaky dams, silt curtains and sonde telemetry. Other maintenance is associated with anti-social activity, such as dumping and vandalism. General maintenance is expected to be carried out on an ongoing basis to ensure that the main items listed in Table 5 are maintained annually and not allowed to deteriorate.

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Table 5: Main items to manage in the general maintenance plan and the required standard

No	Description	Required standard
1	Main forest road.	Maintain good surface dressing, free from potholes.
2	Roadside drains.	Allow to revegetate.
3	Roadside silt traps.	Effective. Water flowing. Not silted up.
4	Roadside dams.	Effective. Water flowing. Not silted up
5	Silt traps in buffer zones.	Effective. Water flowing. Not silted up.
6	Leaky dams in buffer zones.	Effective. Water flowing. Not silted up
7	Dams in buffer zones.	Effective. Water not flowing.
8	Silt traps in restored areas.	Effective. Water flowing. Not silted up.
9	Dams in restored areas.	Effective. Water not flowing.
10	Silt curtains.	Effective and securely in place.
11	Signage.	In good condition, not vandalised.
12	Dumping.	None on site. Remove when observed.
13	Vandalised signage.	Repair when observed.
14	Vandalised forest barriers.	Repair when observed.
15	Access for the public.	Adhere to open forest policy.
16	Restrict public access.	Adhere to Health & safety requirements.
17	Sondes.	Securely in place and operating effectively.

Fire plan

The threat from fires is ongoing on an annual basis in Connemara. For most of the year from June to February the threat is low but from March to May, the threat is high. Between the months of March to May the vegetation is at its driest and most prone to fire. In addition, before it became illegal, the traditional practices of "setting fires" coincides with these months, and unfortunately this practice occurs from time to time. For both of these reasons, the threat of fires needs to be taken seriously in Derryclare and managed.

Fires tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. For infrequent fires there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires, (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return where burning has resulted a bare peat surface (Evans & Warburton, 2007).

Derryclare property lies with the Coillte management area called BAU2. The BAU has a designated fire plan and resources to tackle wildfires at Derryclare if they occur, are part of this fire plan. These

resources include a helicopter call out during the fire season, access to trained fire fighters, established access to local fire brigades, experienced volunteers, and access to the full range of firefighting equipment including fire trailers, beaters, PPE, drones, ATVs, pumps and generators.

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Please refer to the **Fire Plan** included within Appendix 3 for further details.

4.8 Part (h)

It is noted the Derryclare Nature Reserve could expand and the native woodland proposed is adjacent to this Nature Reserve. Additional detail on the woodland habitats including potential ancient woodland indicator species and soil descriptions for Areas A to D in the main EIAR would be useful to ascertain the viability of native woodland establishment in the identified plots.

4.8.1 Response to Part (h)

As Derryclare Nature Reserve itself is not part of the Blanket Bog/Wet Heath restoration project and is owned by NPWS, it was not surveyed as part of this project. Therefore, we cannot provide additional detail on the woodland habitats or ancient woodland indicator species. However, NPWS data from the Derryclare Site Synopsis (SITE SYNOPSIS (npws.ie)) and Conservation Objective Series (Conservation Objectives.rdl (npws.ie)) indicate that the woodland is of very high conservation value, possibly of Ancient woodland origin. The following text derived from these two sources are relevant:

The site (The Twelve Bens/Garraun Complex SAC Site Code: 002031) contains several small areas of Sessile Oak (Quercus petraea) woodland, a habitat which is particularly rare in Connemara. The best examples on the site of this habitat are found at Kylemore and on the north shore of Derryclare Lough. Derryclare Wood, a Statutory Nature Reserve, has been particularly well studied. It is composed mostly of Sessile Oak, with some Rowan (Sorbus aucuparia), Downy Birch (Betula pubescens) and occasional Ash (Fraxinus excelsior) forming the canopy layer. There is a well-developed lichen and fungus flora present. The fungal parasite, Hemigrapha astericus, a native of Australia and South America, was first recorded in the northern hemisphere from this wood (SITE SYNOPSIS (npws.ie)).

and

As part of the National Survey of Native Woodlands (NSNW), Derryclare Wood (NSNW site code 1601) was surveyed by Perrin et al. (2008). Derryclare Wood is also a statutory Nature Reserve (Statutory Instrument No. 177 of 1980) and is well-studied. Map 4 shows that woodland area surveyed by the NSNW, including the area classified as 91A0 (9.5ha). The site contains several small areas of Sessile Oak (Quercus petraea) woodland, a habitat which is particularly rare in Connemara....

Includes ancient or long-established woodlands (Perrin and Daly, 2010), archaeological and geological features as well as red data and other rare or localised species. Perrin and Daly (2010) identified Derryclare Wood (NSNW site code 1601) as possible ancient woodland. There is a well developed fungus and lichen flora present (Folan and Mitchell, 1970) Conservation Objectives.rdl (npws.ie)).

With regard to target objective in Conservation Objectives.rdl (npws.ie)) the Area (should remain) stable or increasing. Where topographically possible, "large" woods at least 25ha in size and "small" woods at least 3ha in size.

In this project, areas immediately adjacent to the Nature Reserve were surveyed (Ecological Report, Hunt, 2021). Target habitats include native woodland establishment, mainly pioneer, wet woodland (equivalent to WN7) in areas B, C & D only. It concluded; There is also potential for native woodland creation which will benefit Derryclare Nature Reserve and provide a more extensive and connected area of native woodland cover.

The main constraints re the viability of newly-established woodlands are exposure and grazing pressure, primarily deer and hares. By combining planted saplings with broadcast seeding and willow cuttings, and the use of tree shelters, losses due to these factors will be compensated to ensure an adequate stocking of ca 800 trees/ha. Only mineral soils and shallow peats (< 35cm max) will be targeted for woodland establishment.

In area B: Native woodland is a further target habitat which has been selected for land adjacent to Derryclare Nature Reserve and for lands in between to create a connected woodland area. Gradual conversion to adapted WN7 due to generally waterlogged peat soils, i.e. (natural regeneration/seed broadcasting/limited planting) to native woodland (pioneer birch with holly, rowan; willow and alder in wetter area; some planting of Scots Pine in dry areas). The total area earmarked for pioneer native woodland establishment here is 11.0 ha located to the N/NE of the Nature Reserve.

In area C: Soils within Area C are dominated by peaty podzols along with peats and acid brown earths. Adapted WN7 conversion is proposed due to generally waterlogged peat soils, i.e. (natural regeneration/seed broadcasting/limited planting) to native woodland (pioneer birch with holly, rowan; willow and alder in wetter area; some planting of Scots Pine in dry areas). The total area earmarked for pioneer native woodland establishment here is 30.6 ha located to the W/NW of the Nature Reserve.

In area D: A small area of protective riparian native woodland (downy birch, common alder, grey willow and rowan) is proposed amounting to 20.4 ha on soils comprising saturated shallow peat and gleyed peaty podzols for the peninsulas to the south and east of the Nature Reserve extending into Derryclare Lake. These will primarily target the aquatic/terrestrial zone.

Note: As all management actions in the project area will be taking place within a sensitive aquatic environment (numerous watercourses; sloping ground to protected lakes), measures to minimise sediment run off and nutrient release are required. This will be achieved through pit planting and generous aquatic buffer zone (30 to 40 m width) riparian woodland establishment (planting, seeding and willow cuttings), strategic native willow and alder establishment for bank stabilisation and filtration services, as well as to provide shading habitat along streams/rivers).

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5. FURTHER INFORMATION ITEM NO. 4

The applicant is required to provide satisfactory information associated with the proposed development with respect to traffic volumes, traffic routes to and from the site, reference to potential impacts to local and national road network and junctions where a Transport and Traffic Assessment is required as well as a road safety audit. Any advance directional signage required for road safety measures, The absence of ground bearing investigation results to confirm suitability of proposed carrying capacity of internal roadway routes & associated structure analysis whereby extensive works are required in predominantly Peat type soil stratums.

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5.1 Part (a)

The applicant is requested to provide clearly identified haul routes proposed to fully assess the public road network being potentially impacted including determination of structure Analysis on the existing roadways to the subject site. All culverts and structures crossed over by HGV's or potential abnormal weight loads should be highlighted in reports which gives details of their structural adequacy

5.1.1 Response to Part (a)

Chapter 13 - Material Assets of the submitted EIAR addresses the likely significant effects of the Proposed Project on transportation infrastructure. This chapter of the EIAR includes details of future traffic volumes and traffic flows for HGVs.

Traffic and Transport Assessment

It is respectfully suggested that that the information presented in Section 13 of the EIAR with respect to traffic volumes, traffic routes, trip generation and the traffic impact on the road network is in accordance with PE-PDV-20045, Transport Assessment Guidelines, TII, May 2014 as stated on Section 13.1.1.2 of the EIAR. These issues are dealt with specifically in the following sections;

- Traffic volumes – A classified turning count survey undertaken at the existing access junction on the R344, together with background traffic forecast for each of the operational years (2023 -2028) is set out in section 13.1.2.3.
- Trip generation and assignment for proposed development – The trip generation for the proposed development is set out for each of these years in Section 13.1.3.1 with the assignment of these trips on routes on the network is discussed in Section 13.1.3.2.
- The traffic impacts of development generated traffic – This is assessed in Section 13.1.5. It was determined that the maximum impact on the R344 would be a +6% increase in terms of PCU. As set out in the EIAR, guidance relating to the requirement to undertake a detailed junction capacity assessment at junctions in the proximity of a proposed development is set out in Document PE-PDV-02045 Traffic and Transport Assessment Guidelines, TII, May 2014. The guidance states that a capacity assessment should be undertaken where the proposed development results in an increase in traffic volumes of 10% or greater, in situations where the network is not currently congested. As the traffic volumes on the R344 are forecast to increase by less than this threshold (maximum +6%) during the proposed development, a detailed capacity assessment was not deemed necessary at the Derryclare Forest Access / R344 junction.
- It is noted that junction improvements, including advanced warning signing is proposed as set out in Section 13.1.4.

Road Safety Audit

The Derryclare forest access on the R344 is an existing junction for which minor improvements, in terms of junction markings and improved visibility splays are proposed. Taking account of this, together with a forecast maximum of 10 HGV movement to and from the proposed development per day. It was considered that a Road Safety Audit would not be required. In the event that an RSA is still requested, the Applicant will commit to completing this request prior to commencement.

Please refer to the **Response to Further Information** prepared by Alan Lipscombe Traffic & Transport Consultants for further details.

5.2 Part (b)

The applicant is requested to provide auto track analysis at the site entrance and within proposed internal layout.

5.2.1 Response to Part (b)

Alan Lipscombe Traffic and Transport Consultants have provided an auto track drawing analysis at the site entrance and within proposed internal layout.

An autotrack assessment for a large articulated HGV (15.4m long x 2.5m wide) exiting the junction is shown in Figure FI3. It is noted that this is an existing access, and these vehicles are currently accommodated at the junction. While based on the forecast traffic volumes it is very unlikely that 2 vehicles will meet at the junction, the figure demonstrates that an HGV accessing the site will be able to wait off the E344 if required.

Please see Figure FI3 within the **Response to Further Information** prepared by Alan Lipscombe Traffic & Transport Consultants for further details.

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6. FURTHER INFORMATION ITEM NO. 5

The applicant is requested to address the following gaps of information and inconsistencies within the submitted information:

6.1 Part (a)

The application contains two separate and contradictory methods of construction for the new 1.58km of internal access roads, the EIAR and the Geotechnical and peat stability Assessment, please finalise proposed methodology.

6.1.1 Response to Part (a)

The EIAR submitted as part of the planning application sets out the methods of construction for the new 1.58km internal access roads. Chapter 4 of the EIAR sets out the details of the existing roads on site, and the details of the proposed New Forestry Access Roads. Please refer to Chapter 4 of the submitted EIAR for further details.

All proposed new forestry access roads will be constructed as build on top/ floating roads as described in Chapter 4 of the EIAR. The peat stability assessment report has been updated to reflect this.

6.2 Part (b)

Please provide precise data relating to the excavation of peat from site to facilitate the new internal access road construction and/or peat excavated from re-profiling, the volumes involved, the means of transport and re-use/disposal within the site of elsewhere.

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6.2.1 Response to Part (b)

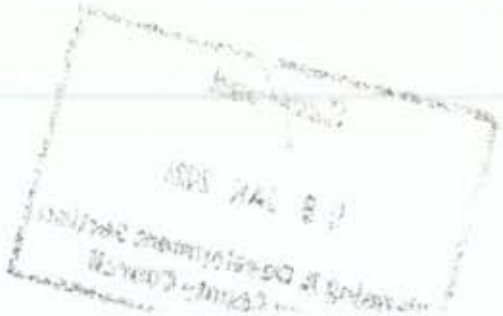
All new internal access roads will be constructed as build-on-top / floating roads as described in Chapter 4 of the EIAR. Therefore, there will be no peat excavated from the site to facilitate road construction. Similarly, there will be no peat excavated for reprofiling. There will be no peat arisings as a result of the proposed project and no necessity to transport or dispose of peat.

6.3 Part (c)

The CEMP should include a section summarising key environmental sensitivities including habitats and water courses as well as all mitigation measures to allow for reporting and monitoring to GCC as a standalone document. This project would require a properly qualified Ecological Clerk of Works, Roles and responsibilities should be clearly defined within the CEMP.

6.3.1 Response to Part (c)

An updated **Construction and Environmental Management Plan (CEMP)** has been prepared by MKO and is submitted with the FI response. All text that has been updated in the CEMP is included in green text. The updated CEMP addresses the inconsistencies identified under item 5(c). It is confirmed that an Ecological Clerk of Works will be appointed on the project and their duties are outlined in Section 4.2 of the submitted CEMP.



APPENDIX 1

DECISION MATRIX FOR SELECTING THE FOREST TO BOG RESTORATION OPTIONS

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Decision matrix for selecting the Forest to bog restoration option.

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Note:

The purpose of this document is to provide decision support for the practitioner in selecting the suitable restoration options to use on site and identify which restoration are unsuitable, based on the prevailing site conditions. It is to be used in conjunction with detailed walk-over site surveys. It is based on current best practice (2023), and it should be updated going forward to reflect any future changes and improvements in best practice, should they arise.

Author: Dr Dermot Tiernan

Date: 19/9/23

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1.0 How to use the decision support matrix

This document is a guide for practitioners to facilitate planning forest to bog restoration projects. It is intended that it will be used in conjunction with a detailed walkover site survey and to be supplemented by appropriate buffer zone management. This tool identifies the acceptable range of restoration options suitable for a given site, so that the practitioner can match the most appropriate restoration options to the site. It is likely that a range of restoration options will be used on each site, and the decision support tool can be used to set the acceptable range from which these options can be selected. This will ensure that the most appropriate restoration options for each site are selected. It should be noted that this document is a planning tool and the best professional judgement of the restoration practitioner on the site should be followed if conditions dictate that a more conservative restoration option be implemented.

1.1 Overview

There is currently no decision support tool to prescribe restoration options on blanket bogs. Developing such a tool can help guide the planner in ensuring the most appropriate restoration option is applied based on the site conditions. However, for the purposes of appropriate assessment, it is recommended that, following the precautionary principle, the mitigations applied for restoration options correspond to the migrations needed for the restoration measure with the highest degree of disturbance and highest level of impact. A decision support tool (see Table 8) was therefore developed using all best available best practice guidelines to help inform management decisions. Mapping in forestry uses compartments and sub-compartments as standard. A compartment is parcel of land, typically 10 to 30 ha in size, that is demarcated on the ground. Within this compartment are smaller sub-compartments, which divide up the sub-compartment into smaller more uninform homogeneous areas. These sub-compartments can be very useful when planning Forest to bog restoration and prescribing the restoration methods suitable for the site. The decision matrix described here is a tool that can be used to select the restoration option most suited to the site, based on the site conditions. The decision matrix requires key site data, and it allows the user to prescribe restoration options appropriate for the underlying site conditions. These site conditions include the peat slide factor of safety, slope, peat depth, soil type (blanket bog or heath) and stump size. The decision matrix is a table that lists all the restoration options (21 permutations) in order of their expected ground disturbance, where option 1 is expected to have the least ground disturbance and option 21 the greatest. The restoration options are also listed in order of their expected speed of restoration, where more intensive restoration methods are assumed to produce speedier restoration (based on the best available literature). The purpose of the decision matrix is to find the restoration option that will cause the least disturbance and deliver the best restoration results and help guide the planner in selecting the best restoration option for the site. The decision matrix can also be used to identify what restoration options are not suitable for the site. In all cases, alternative restoration options can be considered up to, but not above the prescribed option. For example, if a restoration option of 14 is selected, then all options 1 to 14 can be used but no options above 14 can be used. This approach ensures the site is assessed on its ground conditions and provides useful guidance when planning restoration. It should be noted that the decision matrix tool provides recommendations for restoration options and should be used as a guide for management decisions but is not a replacement for the best professional judgement of the restoration practitioner.

2.0 The Forest to bog restoration options.

The Forest to bog restoration options are numbered from 1 to 21 and they are listed in ascending order of expected ground disturbance and in expected order of the speed of likely restoration post works (see Table 1). Buffer zone management is not listed as a restoration option, as the management of buffer zones is a mandatory requirement for all sites. All Forest to bog restoration begins with the installation of buffer zones, which is carried out in advance of restoration options. Buffer zone management is detailed below in section 2.1.

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Table 1: The restoration options listed in order of expected ground disturbance levels and speed of restoration (where 1 is least and 21 is greatest).

Option	21 Restoration options (20 bog restoration, 1 replanting)
1	Fell to waste manually & block interceptor drains
2	Fell to waste manually & fill in interceptor drains
3	Fell to waste manually, block interceptor drains, remove brash from the buffers, windrow
4	Fell to waste manually, fill in interceptor drains, remove brash from the buffers, windrow
5	Fell to waste mechanically & block interceptor drains
6	Fell to waste mechanically & fill in interceptor drains
7	Fell to waste mechanically, block interceptor drains, remove brash from the buffers, windrow
8	Fell to waste mechanically, fill in interceptor drains, remove brash from the buffers, windrow
9	Fell to waste mechanically, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator bucket
10	Fell to waste mechanically, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator bucket
11	Harvest trees & block interceptor drains
12	Harvest trees & fill in interceptor drains
13	Harvest trees, block interceptor drains, remove brash from the buffers, windrow
14	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow
15	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & bucket
16	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & bucket
17	**Harvest trees, remove brash from buffers, windrow & scrap mound (replanting option)**
18	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & grind stumps
19	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & grind stumps
20	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & stump flipping
21	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & stump flipping

The Forest to bog restoration options can be broken down into the following general categories:

- manual interventions (option 1 to 4).
- felling to waste mechanically (options 5 to 10).
- harvesting trees and windrowing (options 11 to 14).
- harvesting trees, windrowing and surface smoothing (options 15 to 16).
- replanting using scrap mounds (option 17).
- harvesting trees, windrowing and stump grinding/flipping (options 18 to 21).

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2.1 Buffer zone management.

Buffer zone management is essential, and they are a central part of the restoration plan. Once the site drainage pattern is mapped, buffers can be put in place along all EPA streams, relevant watercourses, and lakes. The width of the buffer zones will depend on the watercourse and the slope. Recommended buffer widths are given the Table 2 below. Wider buffer zones can be specified where deemed appropriate.

Table 2: Recommended buffer widths for blanket bog restoration.

Watercourse	Gentle slope ($< 6^0$)	Intermediate slope ($6\text{-}11^0$)	Steep slope ($> 11^0$)
EPA streams	20	30	40
Relevant watercourses	10	20	20

Having effective buffer zones installed is the first restoration operation to carry out as it is a key requirement for water quality protection. The function of the buffer zones is to provide protection to the watercourses from subsequent restoration operations. When planning the buffer zones, the goal is to ensure that the buffers are made effective before the restoration activities begin. After tree felling and the removal of brash from the buffer zones, the only operations permitted in the buffer zones are the installation of silt traps and dams on the plough drains, relevant watercourses, interceptor drains and roadside drains. Effective buffer zones will contain a mixture of strategically placed series of silt traps/curtains and dams. Ideally, silt traps should be installed before tree removal begins to afford protection from the harvesting operations. Post felling, a greater number of additional silt traps and dams can be installed (as the site will be more assessable). One these works are completed, the site is left dormant (fallowed) for a period of time, to allow the site to revegetate.

Generally, dams are not effective over slopes of 6 degrees, and it is recommended that larger buffer zones are used on the steeper sites (Table 2). Once the width of the buffer zones is decided, the next step is to walk all the buffer zones and identify which drains within the buffer zone are carrying water. The number of these drains will depend on the original ploughing method. In some cases, the plough drains will not be continued right into the water courses and in these cases, a good buffer may already be in place. However, in the cases where plough drains were continued right into the watercourse, it will be necessary to map all these effective drains that are visibly carrying water. A detailed combined damming and silt trap plan will be required for all these drains, to ensure that the buffer becomes fully effective. If the slope is too steep for effective damming, consider the use of a series of silt traps in combination with methods to slow down the flow rate of the water. Alternatively, install dams further back the drain upstream from the buffer zone, if more suitable locations (slope $< 6^0$) can be found to install the dams and silt traps.

2.2 Fallowing (site revegetation post tree removal).

Fallowing refers to the practice of leaving the site dormant, after the trees are removed, to allow the site to revegetate. (In Derryclare, a sub-catchment approach will be adopted for restoration, so the fallowing period refers to the entire sub-catchment). This practice is a water protection measure to ensure optimum nutrient absorption can occur across the site and especially in the buffer zones. In general, once the timber is removed, works on the buffer zones can be completed, including installation of silt traps, silt curtains and dams. The site is then left dormant (or fallowed), to allow the site and the buffer zones to revegetate. The length of this fallow period will be determined by the effectiveness of the buffer zone and the vegetative cover on site. The effectiveness of the buffer zone, and the length of the fallowing period, will be determined using the on-site water monitoring data, where all water quality values must be within acceptable thresholds. In Derryclare, there is already good existing ground cover under the canopy over most of the site, and recent felled areas within the site have revegetated quickly (usually within a year). It is expected that a fallow period of at least one year will be observed, however, this is conditional on the water quality data downstream from the buffers meeting the acceptable threshold values. Failure to meet the thresholds for the live on-site water quality results, will result in a longer fallow period. When the thresholds for the live on-site water quality results are satisfied, and restoration works begin, all subsequent restoration works will be also subject to meeting the thresholds for the downstream turbidity readings. Failure to meet these turbidity thresholds will result initially in suspension of operations to determine if the issue can be rectified in the short-term. If no satisfactory rectification can be found, the site will have its fallow period extended further, until the threshold values are achieved.

3.0 The decision matrix methodology

The decision support tool developed here uses a 'decision matrix' for recommending the most suitable Forest to bog restoration option. This decision matrix (see Table 8) is a table with all the 21 restoration options listed against the acceptable ranges for each of the key site factors. There are 5 key site factors, namely, a) The peat slide factor of safety, b) Slope, c) Peat depth, d) Soil type (blanket bog or heath) and e) Stump size. This site data was collected for each subcompartment, allowing the user to prescribe a restoration option on a sub compartment level. The decision matrix table allows the user to quickly assess the restoration options based on the key site factors and select the option that has the lowest value. This will ensure that the restoration selected will represent the best acceptable restoration option for the site conditions.

The 5 key site factors are central to what restoration option can be selected and these determine the operational specifications for each restoration option. The decision matrix table allows the user to evaluate these 5 site factors in combination.

What follows is a brief discussion of each of the 5 key site factors, namely,

a) The peat slide factor of safety.

b) Slope.

c) Peat depth.

d) Soil type (blanket bog or heath).

e) Stump size.

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3.1 Peat Stability – Factor of Safety (FoS)

Peat stability is a key factor to understand, to ensure that the peat is not prone to peat slides and that areas of high risk are avoided. Quantifying the peat stability risk will also ensure that appropriate low disturbance restoration options are prescribed in the higher risk areas.

A peat stability analysis is undertaken using the "Best Practice Guide for Proposed Electricity Generation Developments (2nd edition, PLHRAG, 2017). The Peat Landslide Hazard and Risk Assessment Guide (PLHRAG)". This is used for windfarm developments, and it is currently the best available assessment available. It calculates a "Factor of Safety", which is a measure of the peat stability on a particular slope under load. For any slope, the degree of stability depends on the balance of forces between the weight of the soil/peat working downslope (destabilising force) and the inherent strength of the peat/soil (shear resistance) to resist the downslope weight. The purpose of the stability analysis was to determine the stability i.e. Factor of Safety (FoS), of the peat slopes. The FoS provides a direct measure of the degree of stability of a peat slope. A FoS of less than 1.0 indicates that a slope is unstable; a FoS of greater than 1.0 indicates a stable slope. An acceptable FoS for slopes is generally taken as a minimum of 1.3. The stability analysis for this project, which analysed the Restoration Harvest Blocks and access roads (new and existing), resulted in FoS above the minimum acceptable value of 1.3 for both the undrained and drained condition, indicating that the site has a satisfactory margin of safety.

In the decision matrix, when the FoS is less than 1.0, only manual restoration options are recommended (restoration option 1). When the FoS is between 1 and 1.3), only mechanised operations excluding reprofiling are recommended (restoration options 1 to 14). When the FoS is greater than 1.3, mechanised operations including reprofiling are recommended (restoration options 1 to 21).

Table 3: Factor of Safety used for the peat slide risk assessment.

Factor of Safetly (FoS)	Stability	Max restoration option	Restoration option
<1.0	Unstable	1	Manual intervention (1)
1 to 1.3	#Marginally Stable	14	Mechanised excluding reprofiling (1 – 14)
>1.3	Acceptable	21	Mechanised including reprofiling (1 – 21)

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3.2 Slope

The slope of the site has a large influence on the restoration option to prescribe, and the most appropriate restoration option(s) can only be properly prescribed following a detailed walk-over site survey. The drain blocking technique to use depends largely on the slope. Typically, each site will use a range of drain blocking techniques. Careful consideration is required when deciding the drain blocking technique and this is outlined in detail in Appendix 1 of the 'Forest to bog best practice - Best practice operational guidelines for blanket bog restoration in Ireland'. This sets out the situations required for effective drain blocking that can be considered during the pre-works site walk-over survey.

In the decision matrix, slope is a key consideration. The decision support matrix provides a range of options that can be implemented following the pre-works site walk-over survey, but these should only be evaluated with reference to the best practice guidelines outlined in the 'Forest to bog best practice - Best practice operational guidelines for blanket bog restoration in Ireland'. In general, damming options are effective at slopes of 6 degrees or less and not effective on the steeper slopes. In the decision matrix, when the slope is < 6 degrees, all restoration options can be considered. When the slope is between 6 and 15 degrees, restoration options that slow the rate of flow (such as leaky dams) and filling in the drains can be considered. When the slope is > 15 degrees, the effectiveness of restoration options such as slowing the rate of flow and filling in the drains need to be carefully considered, and only restoration options that can operate within the machine specified safe working limit should be considered. The decision matrix for slope provides a planning guide for what restoration option to use, the specific drain blocking technique(s) to adopt will be refined as part of the pre-works walk-over survey.

Table 4: Slope considerations.

Slope (degrees)	Considerations	Drain blocking techniques	Restoration options
<6	• All drain blocking techniques effective	Block drains *and/or* slow flow rate *and/or* fill in drains *and/or* None	1 - 21
Between 6 and 15	• Damming not effective	Slow flow rate *and/or* fill in drains *and/or* None	2, 4, 6, 8, 10, 12, 14, 17, 19, 21
>15	• Damming not effective • All drain blocking techniques may not be effective • Safe working limits of the machine	Slow flow rate *and/or* fill in drains *and/or* None	2, 4, 6, 8, 10, 12, 14, 17

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3.3 Peat depths

Peat depths influence which restoration method is used. Shallower peats are more prone to disturbance, whereas deeper peats are generally more resilient to restoration works. In the decision matrix, when the peat depth is <0.3m, only options 1 to 14 should be considered, and option 17 if the site is designated as suitable for replanting with pioneer native woodland. Where the peat depth is between <0.3m and 0.5m, only options 1 to 14 should be considered. Where the peat depth is between <0.5m and 1.0m, only options 1 to 16 should be considered and where the peat depth is >1.0m, options 1 to 21 (excluding option 17) should be considered.

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Table 5: Peat depth influence on restoration options.

Peat depths (m)	Acceptable level of disturbance	Max restoration option
<0.3m	Fell and windrow, replanting	1- 14 (or 17 if replanting)
0.3 to 0.5m	Fell and windrow	1- 14 (or 17 if replanting)
0.5 to 1.0m	Fell and surface smooth	1- 16 (or 17 if replanting)
>1.0m	All 21 options	1- 21 (excl 17)

3.4 Soil type

The soil type here refers to distinguishing between blanket bog and heath soils. Heath soils are shallow and not suitable for the more intense restoration works and generally these areas will be felled and windrowed only. In the decision matrix, when the soil type relates to a blanket bog, all options (except option 17) can be considered. Where the soil type relates to a heath, only options which relate to minimal disturbance should be used, including replanting of pioneer native woodland.

Table 6: Soil type influence on restoration options.

Peat depths (m)	Acceptable level of disturbance	Max restoration option
Blanket bog	All options	1 – 21 (except 17)
Heath	Fell and windrow	1,2,3,4,5,6,7,8,11,12,13,14,17

3.5 Stump size

Stump size is a consideration, mainly for the stump flipping option. Most of the Forest to bog sites will contain poorly growing trees with small stumps. However, large lodgepole pine (south coastal) stumps (> 45cm in diameter) will occasionally occur, and these stumps are not suitable for stump flipping, as they produce deep rooting tap roots. By comparison, large Sitka spruce stumps (> 45cm) can be flipped, as they produce a shallow root plate along the surface. Current stump flipping practice suggests that large stump sizes are an important consideration and that the larger lodgepole pine stumps should not be stump flipped. In Derryclare, the species, age and yield of the crop was used to predict the stump size into 3 main categories (Table 7) and these were used to ensure that no areas with large lodgepole pine (south coastal) stumps can be selected for stump flipping. Assessing the size of the stump is best done once the crop is felled and the stump can be accurately measured. However, a good estimate of stump size can be predicted at the planning stage. In Derryclare, large stump sizes were predicted for Sitka spruce crops (when their age was 60 years plus and their Yield class was 10 or greater) and for lodgepole pine (when their age was 45 years plus and their Yield class was 10 or greater) with all remaining areas assigned a small stump size.

Table 7: The stump size categories used in the decision matrix.

Stump category	Max restoration option
Small	21
Large lodgepole pine (south coastal)	19
Large Sitka spruce	21

3.6 The decision matrix table

The decision matrix table pulls together all the data from the 5 key site factors and presents them as one easy to read table. The purpose of this table is to allow the user to consider all the 5 key factors collectively. This table is the decision matrix for selecting Forest to bog restoration options and this is shown in Table 8.

Instructions for use

Start with the Peat Slide factor of safety and work from left to right. Select the highest number in each category and work across each category. If there is no change in the listed number between categories, retain that number. If the number is not listed in the subsequent category, then you drop to the next available lower number. Once you drop to a lower number you cannot increase it. Once you move through all categories, the number you are left with is the maximum restoration option you can consider. All restoration options lower than this maximum are also acceptable, but no restoration above this maximum is acceptable.

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Table 8: The decision matrix for selecting Forest to bog restoration options.

Peat slide factor of safety (FOS)			Slope			Peat depth				Soil type		Stump size		
Low (>1.3)	Med (1-1.3)	High (<1.0)	< 6 degrees	6 to 15 degrees	>15 degrees	<0.3m	0.3 to 0.5m	0.5 to 1.0m	>1m	Blanket bog	Heath	Small	Large LPS	Large SS
1	1	1	1			1	1	1	1	1	1	1	1	1
2	2		2	2	2	2	2	2	2	2	2	2	2	2
3	3		3			3	3	3	3	3	3	3	3	3
4	4		4	4	4	4	4	4	4	4	4	4	4	4
5	5		5			5	5	5	5	5	5	5	5	5
6	6		6	6	6	6	6	6	6	6	6	6	6	6
7	7		7			7	7	7	7	7	7	7	7	7
8	8		8	8	8	8	8	8	8	8	8	8	8	8
9	9		9			9	9	9	9	9		9	9	9
10	10		10	10	10	10	10	10	10	10		10	10	10
11	11		11			11	11	11	11	11	11	11	11	11
12	12		12	12	12	12	12	12	12	12	12	12	12	12
13	13		13			13	13	13	13	13	13	13	13	13
14	14		14	14	14	14	14	14	14	14	14	14	14	14
15			15					15	15	15		15	15	15
16			16					16	16	16		16	16	16
17			17	17	17	17	17	17			17	17	17	17
18			18						18	18		18	18	18
19			19	19					19	19		19	19	19
20			20						20	20		20		20
21			21	21					21	21		21		21

Instructions for use.

Start with the Peat Slide factor of safety and work from left to right. Select the highest number in each category and work across each category. If there is no change in the listed number between categories, retain that number. If the number is not listed in the subsequent category, then you drop to the next available lower number. Once you drop to a lower number you cannot increase it. Once you move through all categories, the number you are left with is the recommended restoration option.

See worked examples below on section 4.0.

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4.0 Worked examples.

Below are a few worked examples to demonstrate how the decision matrix may assist in deciding what restoration options, based on the site conditions.

Example 1:

Site conditions	Example	Restoration option
Factor of Safety (FOS)	<1.0	1
Slope	< 6 degrees	1
Peat depth	0.3 to 0.5m	1
Soil type	Blanket bog	1
Stump size	Small	1
Recommended restoration option. Fell to waste manually & block interceptor drains		**1 or less**

Example 2:

Site conditions	Example	Restoration option
Factor of Safety (FOS)	1.0 to 1.3	14
Slope	<6 degrees	14
Peat depth	>1m	14
Soil type	Blanket bog	14
Stump size	Small	14
Recommended restoration option. Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow		**14 or less**

Example 3:

Site conditions	Example	Restoration option
Factor of Safety (FOS)	>1.3	21
Slope	< 6 degrees	21
Peat depth	>1m	21
Soil type	Blanket bog	21
Stump size	Small	21
Recommended restoration option. Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & stump flipping		**21**

Example 4:

Site conditions	Example	Restoration option
Factor of Safety (FOS)	>1.3	21
Slope	5 - 15 degrees	21
Peat depth	0.5 – 1m	14 (17 if replanting)
Soil type	Blanket bog	21
Stump size	Small	21
Recommended restoration option. Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow		14

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APPENDIX 2

DERRYCLARE RESTORATION PLAN FOR PRACTITIONERS

Derryclare Restoration Plan for practitioners

(summary document for practitioners)

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This document is the practitioner's quick reference to the Derryclare restoration plan.

It includes the following:

1. An executive summary for practitioners.
2. A practitioners' management implementation plan (Table 1).
3. Relevant appendices with summaries for the following.
    a. Water monitoring plan.
    b. Invasive species plan.
    c. Grazing management plan (including deer management).
    d. General maintenance plan.
    e. Fire plan.

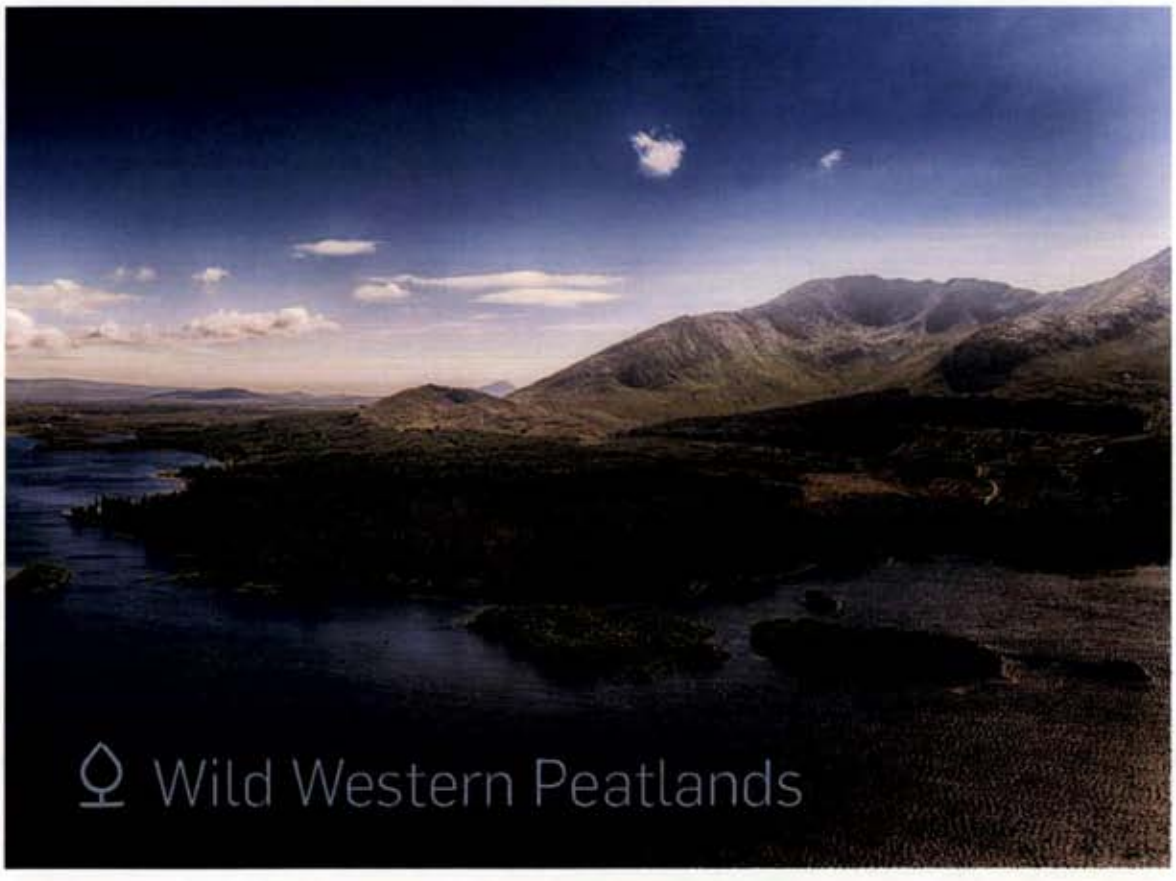

Figure A: Derryclare forest property, Co Galway

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Executive summary for practitioners

Forest to bog restoration occurs in two steps, the initial harvesting plan, and the subsequent restoration works. The first step is to create a harvesting plan for the site. This plan removes the existing tree cover, and this is most effective when as much timber as possible is removed from the site. The harvesting plan for Derryclare was prepared by an experienced forester, based on current best forest planning practices. The preferred best practice harvesting method is to harvest as much timber conventionally (harvester and forwarder combination), where this is not possible, felling to waste is the next preferred option, followed by mulching, which is considered the least favorable option. **The basic management unit for the harvesting plan is the harvest block**. The harvest blocks are designed as practical units for harvesting that facilitate; adherence to existing best forestry practice and safety guidelines, ensure felling is staggered in the four water catchments, ensure coupe sizes are practical, so that they can be harvested safely, ensure the shape of coupes are planned to minimise ground disturbance by avoiding unnecessary water crossings, and ensure disturbance is avoided by making full utilisation of the existing road network. All harvest activities will be monitored for water quality, with appropriate mitigations in place.

Buffer zone management is central to Forest to bog restoration. The management of buffer zones starts with harvesting. where in addition to tree removal, it is also possible to initiate restoration works in the buffer zones. Buffer zones widths will be slope dependent and as a precaution all buffer zones will be at least 30m. Before harvesting, work will start on the buffer zones by installing silt traps and dams, where access permits, as a protective measure for the harvesting operations. Once harvesting is complete, the site becomes fully accessible, and this allows works on the buffer zones to be completed, to ensure the buffer zone also becomes effective for the subsequent restoration works. Once harvesting is finished, the brash will be removed from the buffer zones. To minimise ground disturbance, brash removal is best done by the low ground pressure forwarder machine when the brash is 'fresh'. The forwarder is suitable for this operation because it has the required low ground pressure and a bunk to allow the brash to be easily transported using the existing 'fresh' brash mats. Where the trees are felled to waste, brash removal can be done by either the harvester or forwarder. In areas where the trees are mulched, the buffer zones will be felled to waste manually to allow the trees to be moved outside the buffer zone, where the mulching operation will occur.

The second step in Forest to bog restoration concerns the restoration works. The restoration works for Derryclare are based on a variety of technical expert reports, that were combined, to produce a site-specific restoration plan that will involve peatland habitat restoration (281 ha) and the establishment of pioneer native woodland (62 ha). Suitable locations for pioneer native woodland (62 ha) were identified during the planning phase and these locations are concentrated in areas where the peat depth is shallow (< 30cm in depth), adjacent to the adjoining old woodland nature reserve. **The basic management unit of the restoration work is the sub-catchment (or hydrological peatland unit).** The four water catchments in Derryclare were each further subdivided into 38 sub-catchments. Each sub-catchment relates to an individual hydrological peatland unit. The restoration work is based on scheduling these sub-catchments once; a) the trees are removed, b) the buffer zones are in place and are effective and, c) the site is sufficiently vegetated. Once the trees are removed, each sub-catchment will be subjected to a detailed 'walk-over' survey, where the finer detail of the restoration plan can be assessed, to implement best practice, as provided in the "Forest to bog" guidance document. In terms of managing water movements during the restoration works, the recognised best practice is to starts at the highest point in the sub-catchment and proceed to work downslope. All restoration works will be subject to ongoing monitoring, real time turbidity monitoring and a working procedure to halt works if agreed threshold water quality indicators are exceeded. In addition, contractor management will ensure that work stoppages are fully compensated, and that alternative work off-site will be available, during prolonged wet weather, or where work is completely suspended. All site works will be overseen by the appointed clerk of works for the site, to ensure best practice is followed.

Protecting water quality is central to Forest to bog restoration. All operations will be monitored for water quality, with appropriate mitigations in place. Once the timber is removed and the works on the buffer zones completed, the site is left dormant (or fallowed), to allow the site and the buffer zones to vegetate. The length of this fallow period will be determined by the effectiveness of the buffer zone and the vegetative cover on site. The buffer zone protection measures installed for the harvesting operation will be left in situ post harvesting, and while these alone may be effective to allow restoration works to commence immediately, all additional works on the buffer zones works will also occur post harvesting, when they become assessable. Following these works, the site will be allowed to revegetate, as a further water protection measure. The effectiveness of the buffer zone, and the length of the fallowing period, will be determined using the on-site water monitoring data, where all water quality values must be within acceptable thresholds. In Derryclare, there is already good existing ground cover under the canopy over most of the site, and recent felled areas within the site have revegetated quickly (usually within a year). It is expected that a fallow period of at least one year will be observed for all areas, however, this is conditional on the water quality data downstream from the buffers been consistently under the acceptable threshold values. Any failure to meet the thresholds for the live on-site water quality results, will result in a longer fallow period. When the thresholds for the live on-site water quality results are satisfied, and restoration works begin, all subsequent restoration works will be also subject to been consistently under the thresholds for the downstream turbidity and water quality readings. Failure to meet these thresholds will result initially in suspension of operations to determine if the issue

can be rectified in the short-term. If no satisfactory rectification can be found, the site will have its fallow period extended, until the threshold values are achieved. The live water monitoring will ensure that when thresholds are occasionally exceeded, that remedial action will be taken immediately. It is noteworthy, that in forested areas on peatlands, that exceeding of thresholds values occasionally occurs naturally, but in Derryclare the impact is negligible, as all receiving waters drain into both Lough Inagh and Derryclare lake, where the impact is dissipated as result of the natural dilution capacity of the lakes. The use of live water monitoring and the corresponding procedures put in place to deal immediately with above threshold values, will provide appropriate mitigation.

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Table 1: Summary table of the practitioner's management implementation plan for Derryclare, describing the main actions and associated mitigations in the CEMP plan.

Practitioners' management implementation plan (summary)			
Main phases	**Main tasks**	**Description of actions**	***CEMP mitigation reference***
1. Planning	• Collect baseline water data. • Prepare planning application.	o Collect chemical and biological baseline water data. o Schedule all field survey works. o Interpret field studies and produce a practical site plan. o Felling planned on a harvest block level and restoration works planned on a sub-catchment/sub-catchment level. o Felling plan adheres to forestry standards and best practice. o CEMP plan and clerk of works in place	*MM1, MM2* *MM3, MM4* *MM7*
2. Install water monitoring stations and property wide water protection measures	• Install water stations. • Appoint environmental manager. • Install turbidity stations. • Install strategic water protection measures.	o Erect 2 permanent water monitoring stations to measure water flow and water quality. o Environmental manager appointed. o Erect live turbidity stations downstream in advance of planned operations. o Strategically install silt traps, silt curtains and dams throughout the site, where possible.	*MM4, MM18* *MM32*
3. Construct road extensions	• Construct the new floating roads. • Maintain the existing road network.	o The "Build On-Top Embankment Roads" to follow the COFORD (2004) standard. Movement monitoring posts will be installed. Strict construction methods to be followed see MM36 in the CEMP. o Where necessary, cap the existing roads with clean stone from local stone quarries. o 4 temporary crossings. o Link operations to prevailing weather conditions. o Link operations to prevailing weather conditions. o Follow refueling procedure. o Erect signage and do not construct access and egress routes. o All machinery will be operated by suitably qualified personnel.	*MM3, MM4* *MM14, MM15* *MM18, MM19* *MM24, MM29* *MM30, MM35* *MM36, MM43* *MM47, MM48* *MM49, MM50* *MM52*
4. Advance preparation of the harvest block (HB).	• Install water protection measures along the HB buffer zones. • Conduct the pre-commencement surveys.	o Manually install silt traps, silt curtains and dams along all the buffers in the HB on advance of harvesting/tree removal as a protective measure for the harvesting operations. o Install continuous turbidity monitoring stations downstream in advance of planned harvesting/tree removal. o Carry out HB pre-commencement Bird (Merlin), mammal (Red squirrel) surveys. o	*MM4, MM18* *MM19, MM24* *MM26, MM32* *MM42, MM44*

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Practitioners' management implementation plan (summary)			
Main phases	**Main tasks**	**Description of actions**	**CEMP mitigation reference**
5. Removal of conifer trees	• Carry out harvest operations. • Collect site-specific water samples before, during and after harvesting.	o Carry out plan on a harvest block level as scheduled to Forest Service guidelines and Coillte Health and Safety guidelines. o Site foreman to carry out daily visual inspections. o Collect site-specific water samples before, during and after operations. o Link operations to turbidity thresholds and downstream water quality acceptable thresholds. o Link operations to prevailing weather conditions. o Pay contractor for all downtime. o Link operations to prevailing weather conditions. o Erect signage and do not obstruct access and egress routes. o No refueling, maintenance of machinery or timber stacks within 50m of an aquatic zone or within 20m of any other hydrological feature. o All machinery will be operated by suitably qualified personnel. o Follow refueling procedure. o Adhere to harvest site plan. o Adhere to H&S guidelines.	*MM3, MM4* *MM8, MM9* *MM10, MM11* *MM12, MM13* *MM14, MM15* *MM16, MM17* *MM18, MM19* *MM20, MM21* *MM22, MM23* *MM24, MM25* *MM26, MM27* *MM30, MM32* *MM35, MM37* *MM38, MM39* *MM43, MM47* *MM48, MM49* *MM50, MM52*
6. Initiate buffer zone creation	• Remove brash from buffer zones. • Complete manual works to make the buffer effective.	o Remove brash from all buffer zones at timber removal stage. o Once timer removed and buffers fully accessible, complete the manual installation of silt traps, silt curtains and dams.	*MM13, MM14* *MM16, MM17* *MM18, MM19* *MM21, MM22* *MM23, MM24* *MM26, MM27* *MM30, MM31* *MM32, MM35* *MM39, MM43*
7. Leave site fallow	• Leave site fallow to allow it to revegetate. • Pre-commencement surveys.	o The fallow period applies to the entire sub-catchment/sub-catchment. o Fallow period to be at least 1 year. o Fallow period only complete when the buffer zones is known to be effective. o An effective buffer is when the downstream, monitored water is within the acceptable thresholds, or when the buffer zone works are completed, and the buffer is fully vegetated. o Carry out archeology pre-commencement survey.	*MM4, MM18* *MM19, MM28,* *MM33, MM34,* *MM42,MM44,* *MM45, MM46,* *MM51*

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Practitioners' management implementation plan (summary)			
Main phases	**Main tasks**	**Description of actions**	**CEMP mitigation reference**
8 (a). Carry out restoration works – bog restoration.	• Carry out the planned restoration works.	o Carry out restoration on a sub-catchment basis. o Link operations to turbidity thresholds and downstream water quality acceptable thresholds. o Link operations to prevailing weather conditions. o Pay contractor for all downtime. o Follow refueling procedure. o Erect signage and do not construct access and egress routes. o All machinery will be operated by suitably qualified personnel. o Follow refueling procedure. o Adhere to H&S guidelines. o Carry out a walk-over archaeological survey in advance of restoration works.	*MM3, MM4* *MM9, MM10* *MM11, MM12* *MM13, MM14* *MM15, MM18* *MM19, MM21* *MM22, MM24* *MM27, MM30* *MM32, MM33* *MM35, MM40* *MM42, MM43* *MM47, MM48* *MM49, MM50* *MM51 MM52*
8 (b). Carry out restoration works – pioneer native woodland	1. Deer fence the site 2. Cultivate the site 3. Plant the site 1. Site monitoring	o Erect the deer fence. o Cultivate the site. o Plant. o Monitor for survival.	*MM34, MM35* *MM41, MM43* *MM47, MM48* *MM49, MM52*
9 (a). All phases – monitoring	1. Water monitoring 2. Annual invasives control 3. Grazing management plan (including deer management). 4. General maintenance. 5. Fire plan 6. Site monitoring	o Link operations to prevailing weather conditions. o Daily visual checks by site foreman. o Follow water monitoring plan and ensure links in with operations are in place and followed. o Annual monitoring of tree survival rates where native woodland has been planted. o Invasive species monitoring & annual treatment interventions. o Vegetation monitoring plots have been established and will be used to monitor progress of restoration.	*MM3, MM4,* *MM5, MM6,* *MM15, MM18,* *MM26, MM28,* *MM29, MM30,* *MM35, MM42,* *MM44,MM45,* *MM46, MM47,* *MM48,MM49* *MM50, MM51,*

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Appendix A: Water monitoring plan (summary)

A hydrological monitoring plan has been proposed for the Derryclare Wild Western Peatlands Project and this is summarised in the tables below.

The overall aim of the monitoring plan is to determine the hydrological success of the restoration project. This will be achieved by monitoring several key hydrological parameters pre- and post-construction.

- The key hydrological parameters generally used to characterise the success of a peatland restoration project are surface water flow volumes and the elevation of the peat water table relative to ground level.
- The plan includes the monitoring of groundwater levels, surface water hydrochemistry and flow volumes at appropriate and accessible monitoring locations within the project site;
- The groundwater level monitoring plan utilises the existing piezometer network at the project site, with groundwater levels being continuously recorded by dataloggers and downloaded at 6-month intervals.
- Surface water hydrochemistry and flow volumes will be recorded at 2 no. locations downstream of the proposed restoration works. It is proposed to complete the monitoring through the use of surface water quality probes and auto-samplers.
- Coillte have committed to completing the proposed hydrological monitoring for a period of 12 months pre-construction and for a period of 3-5 years post-construction.
- The pre-construction monitoring will help establish the baseline hydrological characteristics of the Derryclare Site.
- The operation phase monitoring data will be compared to this baseline data and any deviation from the baseline will be used to determine the overall success of the restoration project.
- In addition, intensive water quality monitoring will be completed throughout the construction phase. This water quality monitoring will concentrate on key parameters including turbidity and phosphorus and will be carried out in accordance with the CEMP.
- All data will be downloaded every 6-months and annual monitoring reports and trend analysis will be shared with all stakeholders and the NPWS.

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Monitoring Location	Easting (ITM)	Northing (ITM)	Parameter	Auto/Manual	Monitoring Frequency	Data Download Frequency
Pre-Works Monitoring (Establishing the Baseline)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Auto – sampler/grab samples	Monthly	N/A
			Flow	Auto – flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	Biannual
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See Figure B below		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See Figure B below		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Existing Piezometers	See **Error! Reference source not found.** below		Water level	Auto – logger Manual – dip piezo	Continuous (2-hour intervals) Biannual dips	Biannual

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Monitoring Location	Easting (ITM)	Northing (ITM)	Parameter	Auto/Manual	Monitoring Frequency	Data Download Frequency
Construction Phase (During Works)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
				Manual – grab sampling[1]	1 pre-works, on a weekly basis during works Turbidity event – daily samples until turbidity returns to baseline	N/A
			Phosphorus	Manual – grab sampling	Monthly	N/A
				Auto – sampler	1-week	Weekly
				Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
				Manual – grab sampling	1 pre-works, on a weekly basis during works Turbidity event – daily samples until turbidity returns to baseline	N/A
			Phosphorus	Manual – grab sampling	Monthly	N/A
				Auto – sampler	1-week	Weekly

[1] Construction Phase Only

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				Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See Figure B below		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See Figure B below		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Additional Auto Sampling Locations	Downstream of works area		Turbidity / Temperature / Conductivity	Auto - probe	Continuous (15-minute intervals)	Weekly
Additional Grab Sample Locations	Downstream of works areas		Range of parameters including turbidity and phosphorus	Manual - grab sampling	1 no. sample before felling 1 no. sample during felling 1 no. sample post felling	N/A
Existing Piezometers	See **Error! Reference source not found.** below		Water level	Auto – logger Manual – dip piezo	Continuous (2-hour intervals) Biannual	Biannual

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Monitoring Location	Easting (ITM)	Northing (ITM)	Parameter	Auto/Manual	Monitoring Frequency	Data Download Frequency
Post-Works (Determining the success of the Project)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	N/A
			Flow	Auto –flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See Figure B below		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See Figure B below		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Existing Piezometers	See **Error! Reference source not found.** below		Peat Water level	Auto – datalogger Manual – dip piezo	Continuous (2-hour intervals) Biannual	Biannual

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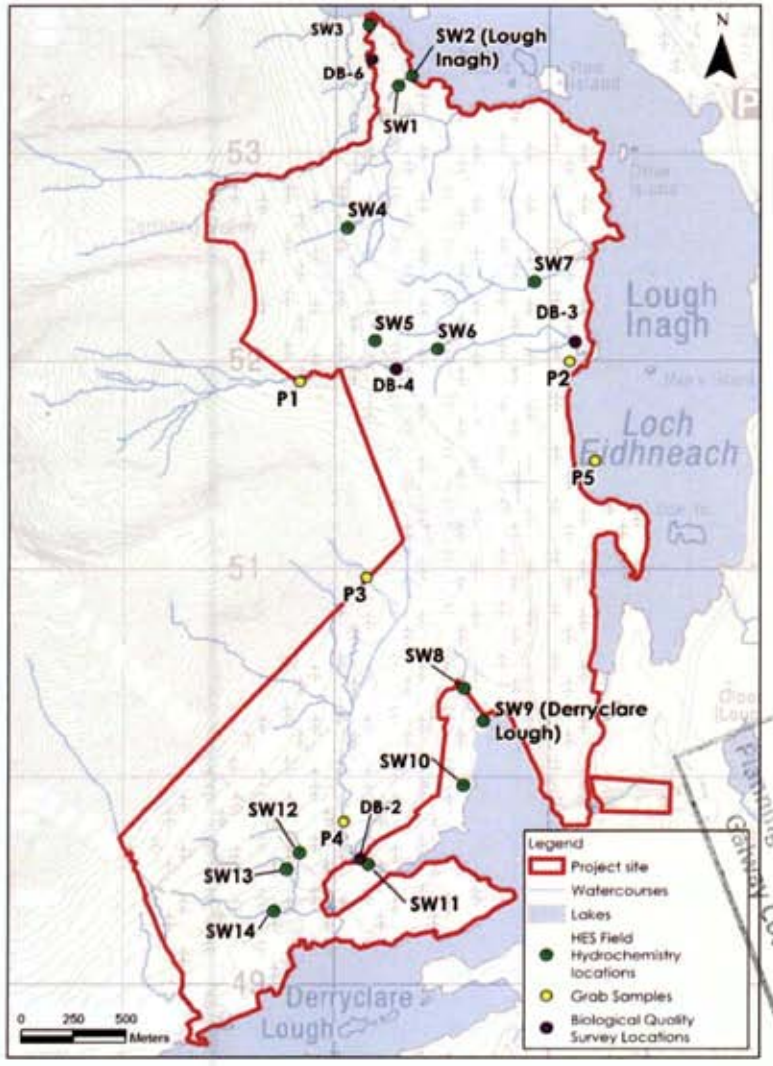

Figure B

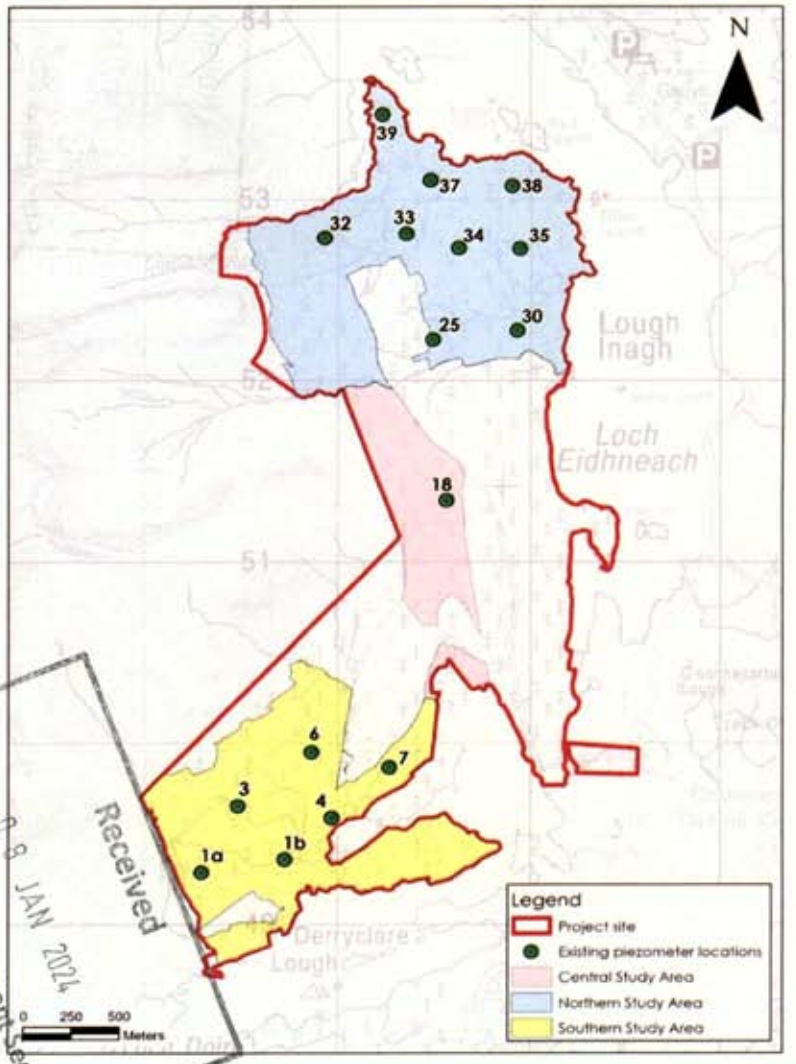

Figure C

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Appendix B: Invasive species plan (summary)

Summary of the invasive species management plan

Following an ecological survey, the main invasive species threat in Derryclare was identified as Rhododendron ponticum and conifer reseeding, with no other invasives observed. The control of rhododendron is a priority as it is seen as one of the largest threats to the success of the restoration works. The baseline data has shown that rhododendron is present at a low-level on a property wide basis and it has the potential to become a large high-level infestation, especially once ground disturbance occurs during restoration. Therefore, annual property wide interventions are planned for Derryclare. The treatment will adopt the methodology researched by the NPWS in the adjoining forest property in Kylemore (described below). The treatment has proven itself to be suited to the conditions in Connemara and it is expected to be a good fit for Forest to bog projects. The entire property will be treated annually, so that by the time initial tree removal begins, most of the rhododendron stems will be dead and can be windrowed along with the forest brash. In addition, all newly restored areas will also be included in the annual treatment, so that all new saplings will be treated or removed. As the restoration programme is spread out over 8 years, the expectation is that all restored areas will be free from rhododendron, and this will be used as one measure to monitor the success of the treatment programme. This annual approach, although intensive, is deemed necessary to manage the rhododendron threat in Derryclare. Intermittent surveys will be carried out to monitor progress, including the visual surveys and sampling surveys described below. New survey methods such as drone surveys or remote sensing can also be adopted, if proved successful. These surveys occur when the rhododendron is flowering and can be a cost-effective way to map a site. Conifer reseeding will be manged in two ways, namely by a) creating unfavourable conditions for seeding germination by removing where possible the raised dry plough ridge using surface smoothing, and 2) where seedlings regenerate, these will be removed when they are young enough to be pulled up out of the ground or cut with a garden lopper. In terms of carrying out the site works, it is planned to link in with Forum Connemara, who in co-operation with the NPWS have set up a dedicated local work gang to treat rhododendron in Connemara. This gang has already been employed to carry out the detailed baseline mapping described below. Treatment of rhododendron will be one of the first actions to be scheduled and it will remain a priority throughout the project.

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Table 2: The planned schedule for managing rhododendron in the Derryclare bog restoration programme.

Year	Bog restoration schedule	Rhododendron treatment
0	Secure planning permission and felling licences.	• Property wide treatment of all mature rhododendron plants and seedlings in flower.
1	Year 1 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Monitor emerging seedlings from recently restored areas.
2	Year 2 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower • Pull/threat emerging seedlings from recently felled areas. • Monitor emerging seedlings from recently restored areas.
3	Year 3 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from year 1 & 2 felled areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline.
4 to 7	Year 4 to 7 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas. • Monitor emerging seedlings from recently restored areas.
8	Year 8 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline.

Appendix C: Grazing management plan (including deer management) (summary)

Summary

The grazing pressure in Derryclare comes from livestock (mostly sheep) and deer. The maintenance plan initially involves the construction of an external sheep fence to ensure that the entire property is fenced off. All livestock will be removed before the fence is completed. An internal deer fence will be erected to fence off the area where pioneer native woodland will be established. The site will be monitored for trespass and appropriate action taken where required, up to and including impounding. Regular checks will be made to the fence-lines to ensure they remain intact, and any breaches or faults will be repaired as a matter of urgency. Coillte have a process for impounding livestock and this process will be followed if impounding is required. Deer culling will not be used in the grazing maintenance plan as Coillte do not own the shooting rights on site. Any deer culling will only occur in agreement with the relevant stakeholders and within the law. To date, there are no immediate plans to carry out any deer culls.

Table 3: The grazing management plan by year during the restoration works.

Years	Restoration plan	Grazing plan
0 (2023)	Secure planning permission and felling licences.	• Complete external sheep fence on external boundary. • Exclude livestock from all site. • Monitor all site for trespass.
1 (2024)	Bog restoration site.	• Check sheep fence line. • Monitor all site for trespass.
2 (2025)	Pioneer native woodland sites.	• Erect deer fence stage 1. • Check sheep fence line. • Monitor all site for trespass.
3 (2026)	Pioneer native woodland sites.	• Erect deer fence stage 2. • Check sheep fence line. • Monitor all site for trespass.
4 to 8	Bog restoration sites.	• Check deer fence line. • Check sheep fence line. • Monitor all site for trespass.

Appendix D: General maintenance plan (summary)

Summary

General maintenance is a catch all that refers to addressing outstanding issues, other than invasive species, deer and livestock grazing and fire, which are all detailed separately. General maintenance on this plan includes a wide variety of tasks such as road maintenance, silt trap and dam inspections and repairs, public usage, dumping, vandalism, erection, and repair of signage, dealing with the public and local requests arising from consultations. For Derryclare the most important general maintenance is expected to be silt trap and dam inspections and maintenance, keeping the main access road in good repair and dealing with issues with the general public such as dumping and vandalism.

Table 4: Main items to manage in the general maintenance plan and the required standard.

No	Description	Required standard
1	Main forest road.	Maintain good surface dressing, free from potholes.
2	Roadside drains.	Allow to revegetate.
3	Roadside silt traps.	Effective. Water flowing. Not silted up.
4	Roadside dams.	Effective. Water flowing. Not silted up
5	Silt traps in buffer zones.	Effective. Water flowing. Not silted up.
6	Leaky dams in buffer zones.	Effective. Water flowing. Not silted up
7	Dams in buffer zones.	Effective. Water not flowing.
8	Silt traps in restored areas.	Effective. Water flowing. Not silted up.
9	Dams in restored areas.	Effective. Water not flowing.
10	Silt curtains.	Effective and securely in place.
11	Signage.	In good condition, not vandalised.
12	Dumping.	None on site. Remove when observed.
13	Vandalised signage.	Repair when observed.
14	Vandalised forest barriers.	Repair when observed.
15	Access for the public.	Adhere to open forest policy.
16	Restrict public access.	Adhere to Health & safety requirements.
17	Sondes.	Securely in place and operating effectively.

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Appendix E: Fire plan (summary)

Summary

The threat from fires is an annual threat in Connemara. For most of the year from June to February the threat is low but for the months from March to May, the threat is high. Between the months of March to May the vegetation is at its driest and most prone to fire. In addition, before it became illegal, the traditional practices of "setting fires" coincides with these months, and unfortunately this practice occurs illegally from time to time. For both of these reasons, the threat of fires needs to be taken seriously in Derryclare and managed. Fires tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. For infrequent fires there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires, (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return when burning has produced a bare peat surface (Evans & Warburton, 2007).

Derryclare property lies with the Coillte management area called BAU2. This BAU has a designated fire plan and resources to tackle wildfires and Derryclare will remain part of this fire plan. These resources include a helicopter call out during the fire season, access to trained fire fighters, established access to local fire brigades, experienced volunteers, and access to the full range of firefighting equipment including fire trailers, beaters, PPE, drones, ATVs, pumps and generators.

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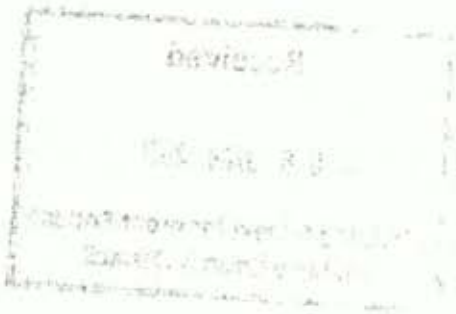

APPENDIX 3

BIOLOGICAL & CHEMICAL MONITORING OF SURFACE WATERS REPORT PREPARED BY MAYFLY ECOLOGY

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ECOLOGY

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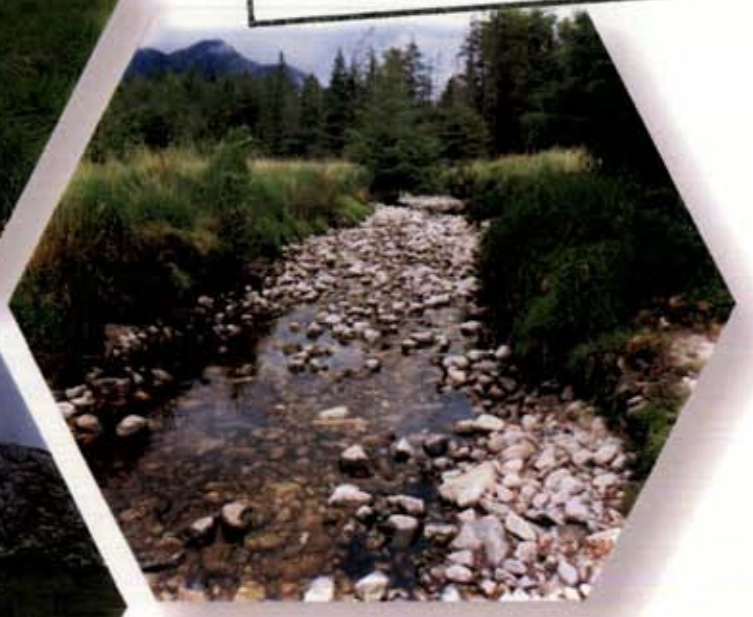

Biological & Chemical Monitoring of Surface Waters

Derryclare & Cappaghoosh

21st July 2023

Draft Version 01

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Acronyms

DB – Derryclare biology
CB – Cappaghoosh biology
EPA – Environmental Protection Agency
EQS – Ecological Quality Standard
LOD – Limit of Detection
QI – Qualifying Interest
Ortho-P – Orthophosphate
OSI – Ordnance Survey Ireland
OSI – Ordnance Survey Ireland
SAC – Special Area of Conservation
SPA – Special Protection Area
WFD – Water Framework Directive

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1. INTRODUCTION

1.1. Background

The Wild Western Peatlands is a Coillte Nature project which aims to restore and rehabilitate approximately 2,100 hectares of Atlantic blanket bog and wet heath currently planted with commercial spruce and pine forests. Part of this project involves the regular biological and chemical monitoring of surface waters.

Mayfly Ecology was commissioned by Coillte to undertake a programme of biological monitoring (macroinvertebrates) of surface waters at 11 sites across the Derryclare and Cappaghoosh properties in Co. Galway. The sites had been previously selected by Coillte via desktop analysis and this survey represented the first round of monitoring. Therefore, sites needed to be verified on the ground to assess whether they were suitable for biological monitoring. It is intended that suitable sites will then be surveyed on an annual basis. The first round of biological monitoring for all 11 sites was undertaken by Letizia Cocchiglia of Mayfly Ecology.

A programme of monthly water sampling for chemical analysis commenced in January 2023 at 18 sites across Derryclare and Cappaghoosh properties. Water sampling was undertaken by Coillte and laboratory analysis by Fitz Scientific. Mayfly Ecology was commissioned to analyse the results of the chemical analysis.

This report summarises the results of the June 2023 biological monitoring for the 11 sites and also summarises the first set of results of the monthly chemical analysis for 18 sites. The results will represent a baseline condition prior to any remediation works being carried out for both properties.

1.2. Site Location and Description

The biological and chemical sample sites are split between two properties, Derryclare and Cappaghoosh in Connemara, Co. Galway (**Figure 1-1** & **Figure 1-2**). The sample sites within Derryclare are displayed in **Figure 1-3** and for Cappaghoosh the sites are displayed in **Figure 1-4.** General site details can be found in **Table 1-1** & **Table 1-2** for each property and each is described separately below.

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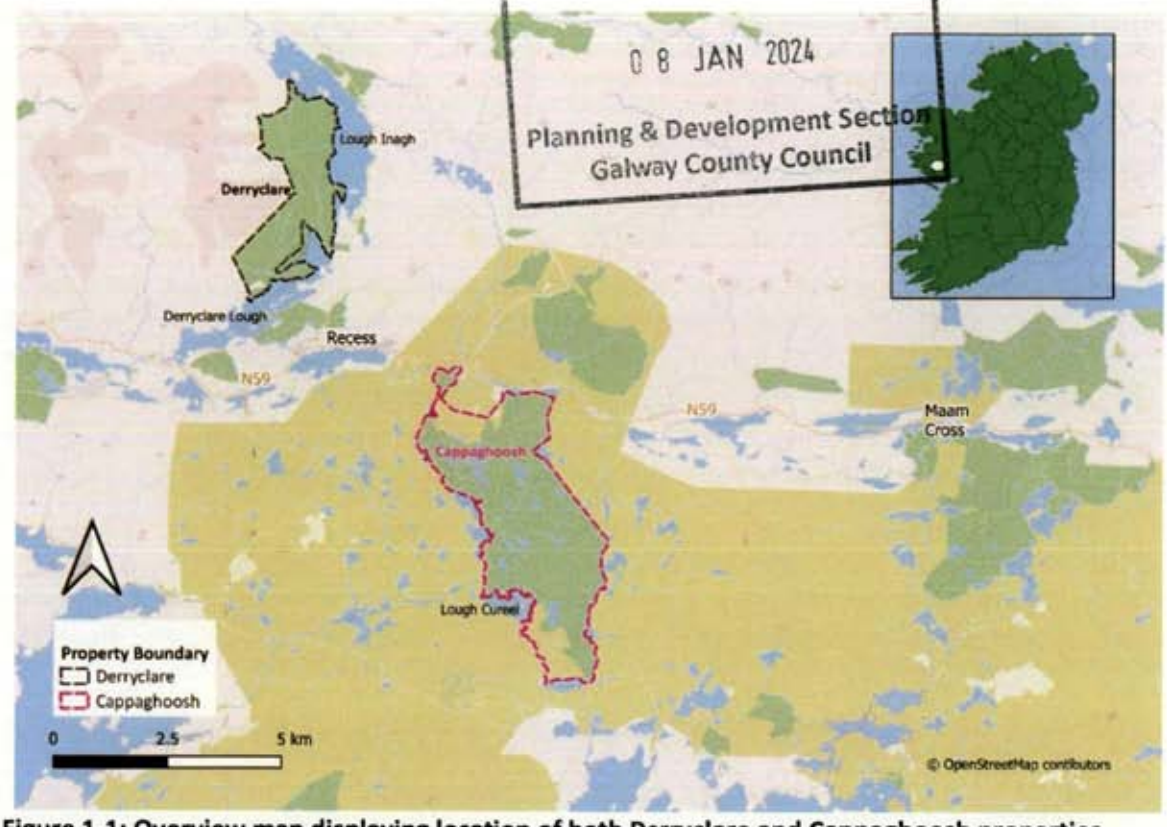

Figure 1-1: Overview map displaying location of both Derryclare and Cappaghoosh properties.

Figure 1-2: Aerial image of the Derryclare and Cappaghoosh properties.

1.2.1. Derryclare

The Derryclare property is located in Connemara near Recess, Co. Galway just north of the N59 Galway to Clifden road. General property co-ordinates are 53.49521, -9.74929. The property is nestled between the Twelve Bens Mountain range to the west and the shorelines of Lough Inagh and Derryclare Lough to the east and south respectively. The Twelve Bens/Garraun Complex Special Area of Conservation (SAC) borders the entire property and includes both aforementioned loughs. Qualifying interest (QI) habitats of this SAC include; Old oak woodland [91A0], Alpine and subalpine heath [4060], Blanket bogs [7130], Rhynchosporion depressions [7150], Rocky slopes [8210,8220], Oligotrophic isoetid lake [3110] and Mixed *Najas flexilis* lake [3130]. QI species include; Freshwater pearl mussel [1029], Atlantic salmon [1106], Otter [1355] and Slender naiad [1833]. Derryclare Nature Reserve is located in the south western section of the property which contains one of the best examples of old oak woodland within the SAC and a successful red squirrel introduction programme was undertaken here in 2005.

Brown trout, sea trout and Atlantic salmon are known to occur in both Inagh and Derryclare loughs. There are historic records (1945) of Arctic charr within Derryclare. More recent records of Artic charr exist in Lough Inagh with anglers reported to be catching the occasional charr up to 2001 (Igoe *et al.*, 2003). The current status of this glacial relict in these lakes is unknown.

Both loughs and the rivers flowing into them are within the Ballynahinch -Ballynahinch Lake freshwater pearl mussel sensitive area. There have been records of this species in this catchment but current status is unknown.

Six sites had been selected via desktop analysis for biological sampling and five sites for water chemistry analysis. Most of the rivers here rise from the steep slopes of the Twelve Bens Mountain range and flow in an easterly / south easterly direction before entering Inagh or Derryclare loughs. These are relatively short rivers under 3km in length. In the upper reaches they are typical fast boulder dominated mountain streams, while the lower reaches are characterised by blanket bog and heath most of which has been afforested. None of these rivers are named on OSI mapping. They are all coded as being part of the Recess_020 waterbody by the EPA.

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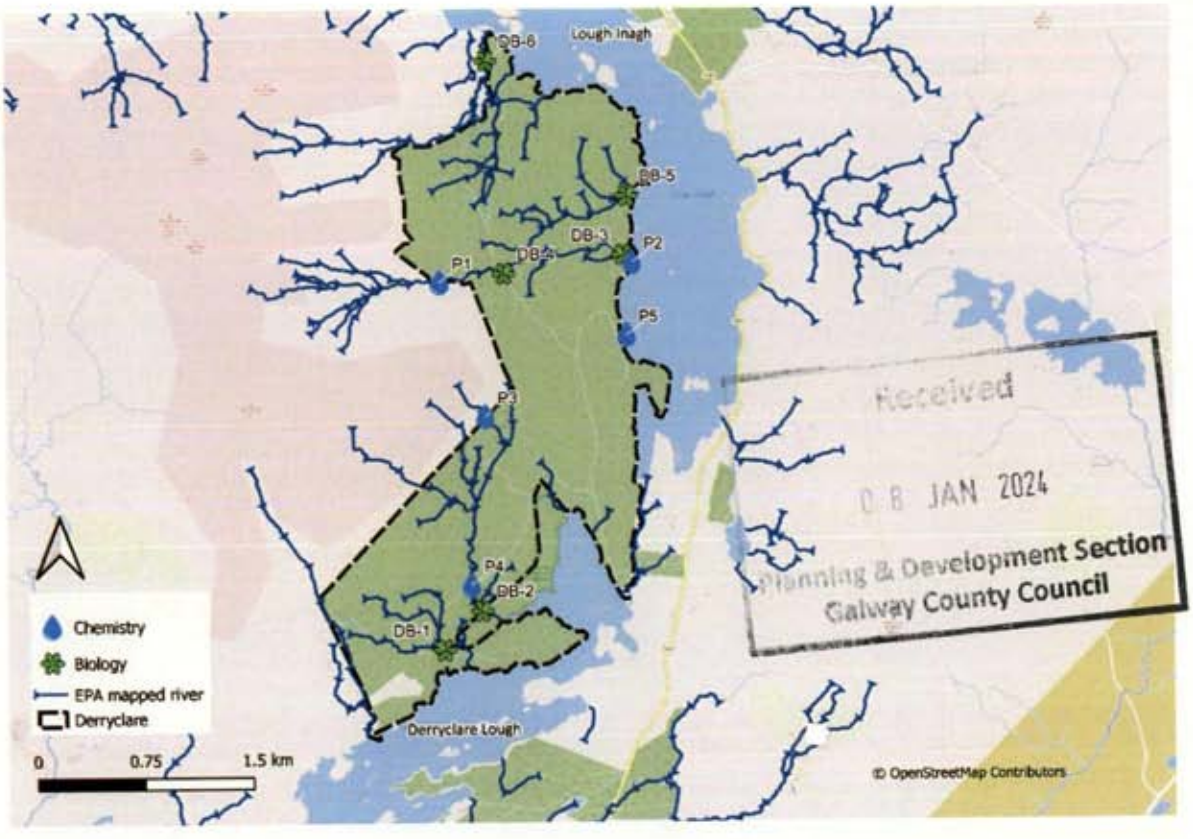

Figure 1-3: Map displaying sample site locations in the Derryclare property.

1.2.2. Cappaghoosh

The Cappaghoosh property is also located near Recess, Connemara in Co. Galway. General coordinates for the property are 53.44478, -9.68832. Cappaghoosh lies directly south-east of Derryclare and south of the N59 Galway to Clifden road. The Connemara Bog Complex SAC borders almost the entire property. This is a large SAC with extensive tracts of blanket bog and many other varied habitats. QI habitats include; Oligotrophic isoetid lake [3110] and Mixed *Najas flexilis* lake [3130], Acid oligotrophic lake [3160], Vegetation of flowing waters [3260], Wet heath [4010], Dry heath [4030], Molinia meadows [6410], Blanket bog [7130], Transition mires [7140], Rhynchosporion depressions [7150], Alkaline fen [7230] and Old oak woodland [91A0]. This is a large SAC stretching to the coastline and also includes some marine QI habitats. QI species includes; Marsh fritillary [1065], Atlantic salmon [1106], Otter [1355] and Slender naiad [1833]. It is also surrounded by the Connemara Bog Complex SPA designated for Cormorant [A017], Merlin [A098], Golden plover [A140] and Common gull [A182].

Little information is known about the fish populations within waterbodies that flow through Cappaghoosh. To the north and outside of the property, Lough Glendollagh is private fishery with Atlantic salmon and brown trout. This lake is downstream of sample sites CB-A and CB-B and it is considered likely salmon and trout would also be present within the river at these sites. There are also historic records (1945) of Arctic charr within this lake but current status is unknown (Igoe *et al.*, 2003).

The rivers within the Cappaghoosh property are not designated as freshwater pearl mussel sensitive areas but the river at site CB-A and CB-B is designated as the Ballynahich- Caher freshwater pearl mussel sensitive area falling into the category: Catchments with other extant populations.

The Cappaghoosh property lies within a relatively flat landscape consisting of mainly blanket bog. It is studded with numerous lakes that are interconnected with small streams and rivers. A large portion of the bog had been afforested with spruce and pine. Some areas of bog remain intact (albeit modified) and in 2007 some bog remediation took place in Cappaghoosh. A programme of tree felling to waste was undertaken with some minimal drain blocking along the north and north east of Lough Curreel.

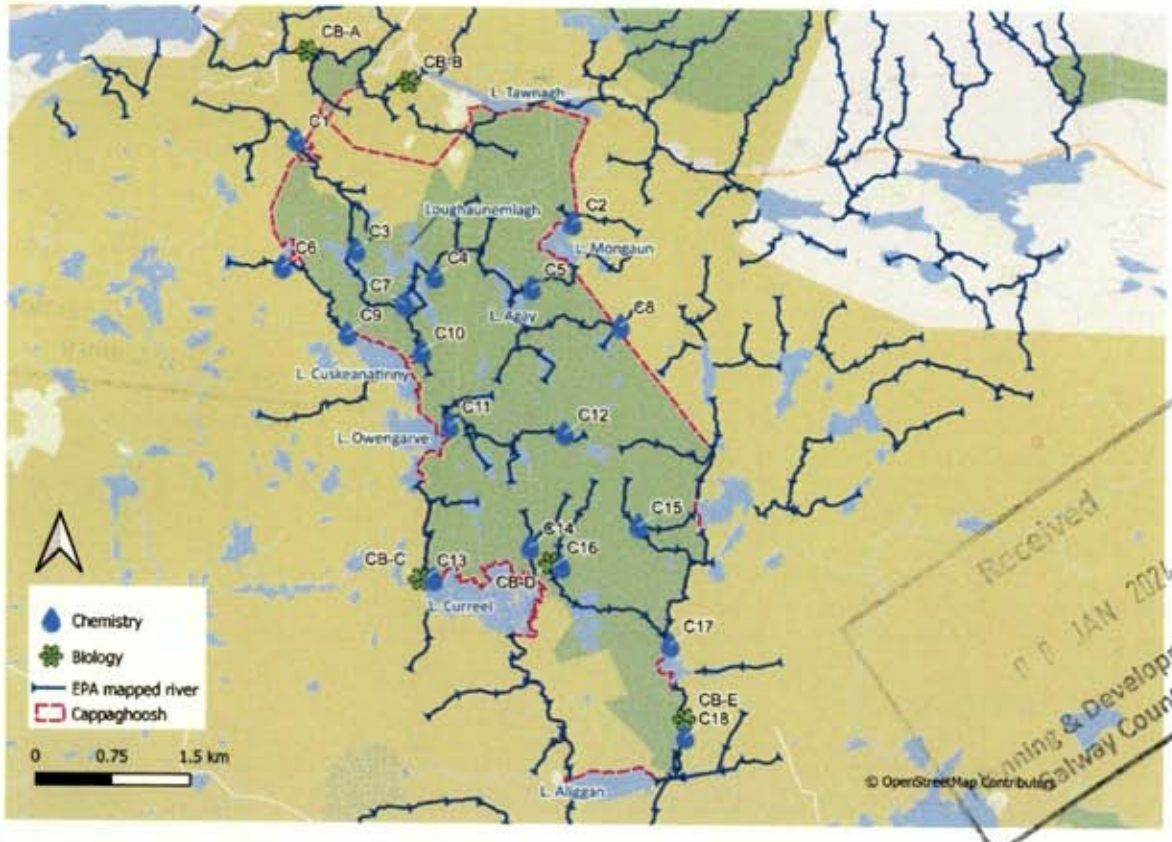

Figure 1-4: Map displaying biological and chemical sample sites in the Cappaghoosh property.

Table 1-1: Site coordinates and codes for biological monitoring points, DB = Derryclare Biology, CB = Cappaghoosh Biology

Site code	Property	Lat	Long	EPA waterbody name	Description (approx. length of main channel)
DB-1	Derryclare	53.48118	-9.76519	Recess_020	Rises within Derryclare property, flows through the nature reserve and discharges to Derryclare Lough (c.1km).
DB-2	Derryclare	53.48367	-9.76132	Recess_020	Rises in foothills of Derryclare Mt. Flows though the nature reserve and discharges to Derryclare Lough (c. 2km).
DB-3	Derryclare	53.50622	-9.74725	Recess_020	Rises between Bencorr and Derryclare Mts and enters Lough Inagh (c. 2.8km).
DB-4	Derryclare	53.50484	-9.75973	Recess_020	Located c.935m u/s of DB-3 in same channel (c. 2.8km).
DB-5	Derryclare	53.50996	-9.74706	Recess_020	Rises within the Derryclare property and discharges to Lough Inagh (c. 1.2km).
DB-6	Derryclare	53.51832	-9.76209	Recess_020	Rises at Bencorrbeg Mt and discharges to Lough Inagh opp. Deer Island. (c. 2.5km).

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Site code	Property	Lat	Long	EPA waterbody name	Description (approx. length of main channel)
CB-A	Cappaghoosh	53.46323	-9.71129	Recess_010	Also known as Caher/Owentooey River. This channel section flows from Lough Tawnagh (Park Lough) and discharges to Glendollagh Lough (c. 3.2km).
CB-B	Cappaghoosh	53.46084	-9.6966	Recess_010	1.7km u/s of CB-A in same channel. This site is c. 150m downstream Tawnagh Lough.
CB-C	Cappaghoosh	53.41824	-9.69301	Invermore_020	Also known as Owengarve River. This channel section flows from Owengarve Lough and discharges to Lough Curreel (c. 1km). Site is just u/s L. Curreel
CB-D	Cappaghoosh	53.41996	-9.67442	Invermore_010	Rises from small lough near the centre of Cappaghoosh property and discharges to Lough Duff and then flows into Bunnahask Lough (c. 2.5km).
CB-E	Cappaghoosh	53.40698	-9.65463	Invermore_010	Rises from Bunnahask Lough and discharges to Lough Alligan (c. 930m).

Table 1-2: Site coordinates and codes for water chemistry monitoring points.

Site code	Property	Lat	Long	EPA waterbody name	Description (approx. length of main channel)
P1	Derryclare	53.5042	-9.7665	Recess_020	Located in same channel as biological sample DB-3 & DB-4. Site is c. 490m u/s DB-4
P2	Derryclare	53.50576	-9.74633	Recess_020	Located in same channel as biological sample DB-3 & DB-4. Site is c. 105m DB-3 just before river enters Lough Inagh.
P3	Derryclare	53.49583	-9.76142	Recess_020	Rises in foothills of Derryclare Mt. Site is a small 1st order stream in the upper reaches. P4 sample site is 1.3km d/s in main channel. Biological sample site DB-2 is also in main channel c.1.6km d/s.
P4	Derryclare	53.48528	-9.76255	Recess_020	Rises in foothills of Derryclare Mt. Located 1.3km d/s P3 and 0.3km u/s DB-2.
P5	Derryclare	53.50114	-9.74674	Lough Inagh	Western shoreline of Lough Inagh.
C1	Cappaghoosh	53.45552	-9.71249	Invermore_020	Short river u/s of the north-western boundary of Cappaghoosh property. Sample site just before river enters Loughaunanny (1.1km)
C2	Cappaghoosh	53.44907	-9.67266	Invermore_020	Short river u/s of the north eastern boundary of property. Sample site just before river enters Lough Mongaun (713m)
C3	Cappaghoosh	53.44620	-9.70342	Invermore_020	River within north-western section of property Sample site just u/s Lough Fadda. Channel rises from Loughaunanny.
C4	Cappaghoosh	53.44415	-9.69217	Invermore_020	River within northern section of property. Site is between Loughaunemlagh and Lough Agay.
C5	Cappaghoosh	53.44342	-9.67822	Invermore_020	Site within north-eastern section of property just before outlet to L. Agay.
C6	Cappaghoosh	53.44458	-9.71388	Invermore_020	Short channel just outside and u/s of north—western section property. Sample site just before outfall to Lough Minnaun and d/s of Clogheratinny Lough.

Site code	Property	Lat	Long	EPA waterbody name	Description (approx. length of main channel)
C7	Cappaghoosh	53.44169	-9.69634	Invermore_020	River within north-western section of property. Sample site between Lough Fadda and Loughaunemlagh.
C8	Cappaghoosh	53.44042	-9.66535	Invermore_020	Site just outside eastern boundary and u/s of property. Near source of river which flows toward Lough Agay.
C9	Cappaghoosh	53.43903	-9.70434	Invermore_020	Site on north western boundary of property. Sample site just before L. Cuskeanatinny and d/s L. Minnaun.
C10	Cappaghoosh	53.43770	-9.69373	Invermore_020	Site within western section of property just before L. Cuskeanatinny and d/s Loughaunemlagh
C11	Cappaghoosh	53.43149	-9.68945	Invermore_020	Western boundary of property just before outlet to L. Cuskeanatinny.
C12	Cappaghoosh	53.43112	-9.67291	Invermore_020	Central section of property and same channel as C12 but located in upper reaches of the channel.
C13	Cappaghoosh	53.41827	-9.69246	Invermore_020	South-western boundary of property just before outlet to L. Cureel.
C14	Cappaghoosh	53.42131	-9.67738	Invermore_020	Within southern section of property upstream of L.Cureel.
C15	Cappaghoosh	53.42339	-9.66194	Invermore_010	Within south eastern section of property within short channel flowing toward L. Arusheen
C16	Cappaghoosh	53.41971	-9.67394	Invermore_010	Same monitoring point as biology sample CB-D. Rises from small lough near the centre of Cappaghoosh property and discharges to Lough Duff and then flows into Bunnahask Lough. Site can be dry and in this case the sampler took samples from the drainage ditches perpendicular to the river.
C17	Cappaghoosh	53.41326	-9.65692	Invermore_010	On boundary of southern section of property just before outlet to L. Bunnahask
C18	Cappaghoosh	53.40548	-9.65441	Invermore_020	Rises from Bunnahask Lough and discharges to Lough Alligan (c. 930m).

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2. METHODOLOGY

2.1. Desktop Review of Existing Water Quality

A desktop review was completed to gather baseline water quality information. The review included a search of current Water Framework Directive (WFD) status and summary of EPA biological monitoring results (if available).

The characterisation process for the 3rd Cycle River Basin Management Plan has been completed and the report for the relevant catchment was reviewed. The results of this process for the survey site are summarised in the results.

WFD Priority Areas for Action are areas where action will be carried out in the River Basin Management Plan (RBMP). The Areas for Action were selected based on the priorities in the RBMB, the evidence from the WFD characterisation process, and the expertise, data and knowledge of public

body staff with responsibilities for water and the different pressure types. The Local Authority Waters Programme (LAWPRO) conduct assessment work within the Area for Action. EPA mapping tools were used to assess if the relevant water bodies lie within a Priority Area for Action.

The following sources were consulted to conduct the desktop review.

- Environmental Protection Agency (EPA) online mapping tools (https://gis.epa.ie/EPAMaps) and (https://www.catchments.ie/maps/) for waterbody information and mapping;
- Environmental Protection Agency (EPA) catchment characterisation report (EPA 2021) Available online (https://catchments.ie/wp-content/files/catchmentassessments/25B%20Lower%20Shannon%20Catchment%20Summary%20WFD%20Cycle%203.pdf).

The main biological index used by the EPA in determining the quality of Irish rivers is the Q-value. **Table 2-1** below summaries the Q-value index and relationship with water quality. The desktop review included a search of the EPA biological monitoring data results from the closest monitoring station relevant to the proposed development.

Table 2-1: Relationship between the Q-value and water quality (Table adapted from EPA river quality survey reports).

Q-value	Biological Quality[1]	Pollution Status	Condition
Q5, Q4-5	High	Unpolluted	Satisfactory
Q4	Good	Unpolluted	Satisfactory
Q3-4	Moderate	Slightly polluted	Unsatisfactory
Q3, Q2-3	Poor	Moderately polluted	Unsatisfactory
Q2, Q1-2, Q1	Bad	Seriously polluted	Unsatisfactory

2.2. Survey Methodology

Water samples were taken by Coillte once a month from January/February to April 2023 across 18 sites. The methodology for sampling is not described in this document as it was conducted by another party. For the same reasons the methodology for water chemistry analysis is not described but followed standard operating procedures for each parameter. In total 21 parameters are analysed and these are listed below.

Alkalinity (mg/L $CaCO_3$)	Manganese (µg/L)
Aluminium (µg/L)	Nickel (µg/L)
Ammonia (mg/L as N)	Nitrate (mg/L as N)
Calcium (mg/L)	pH (pH Units)
Conductivity (at 20C)	Phosphate-Ortho (mg/L)
Copper (µg/L)	Phosphorus-Total (mg/L as P)
Dissolved Organic Carbon (mg/L)	Potassium (mg/L)
Dissolved oxygen (mg/L)	Sodium (mg/L)
Hardness Total (mg/L $CaCO_3$)	Solids-Total Suspended (mg/L)
Iron (µg/L)	Zinc (µg/L)
Magnesium (mg/L)	

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[1] The Q-value has been developed for rivers only. It does not equate to WFD Status however, in Ireland it is often the driving element in status assignment. It is the most common index that is used to calculate Ecological Status for the WFD. The other biological indicator used in rivers is fish and monitored by Inland Fisheries Ireland.

A freshwater ecology survey was undertaken in Derryclare and Cappaghoosh on the 15th-17th June 2023. The following information was collected during the freshwater ecology survey and detailed methodology for each of these surveys is given in the following sections below.

- General habitat survey (includes physical characteristics and riparian zone structure)
- Biological quality survey - Macroinvertebrates
- Aquatic plant observations (macrophyte, macroalgae, bryophytes and liverwort)
- Physiochemical parameters
- Invasive species observations
- Other species/ features of note

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2.2.1. General River Habitat Characteristics

At each sampling location the general river habitat characteristics were recorded broadly following those listed within the Environment Agency's *'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual'* (EA, 2003) and *Northern Ireland Environment Agency's 'River Hydromorphology Assessment Technique (RHAT) Training Manual* (NIEA, 2014). Characteristics recorded include the following;

- Substrate type, degree of overlying sediment and note of sediment generated when substrate disturbed.
- Flow conditions and velocity.
- Riparian zone structure which includes a list of the dominant bankside vegetation and degree of shading along the river.
- General hydromorphological characteristics including; river depth, width, bank height, signs of erosion or modification and barriers to connectivity.

2.2.2. Physio-chemical parameters

Hand held probes were used to record physiochemical parameters insitu. Probes used included Oxygaurd Handy Polaris and Hanna Combo which were calibrated before use.

- Dissolved oxygen (% and mg/l).
- pH (pH unit).
- Temperature (°c).
- Conductivity (µS/cm).

2.2.3. Biological Quality Survey - Macroinvertebrates

Macroinvertebrates were collected using a two-minute (or longer may be required in certain substrate conditions) kick sampling method with a standard hand net (1 mm mesh). The survey technique adhered to ISO Standard 10870:2012 and CEN FprEN 16150:2011 for kick sampling and utilised the EPAs standard protocol. Stone washing (1 minute) was also undertaken to ensure collection of species which cling to rock surfaces. The collected sample was tipped into a white tray and macroinvertebrates identified in the field to the lowest taxonomic level possible.

The main biological index used by the EPA in determining the biological quality of Irish rivers is the Q-value. This ranges on a scale from Q1 (Bad biological quality) to Q5 (High biological quality).

The Q-value is based on macroinvertebrate sensitivity to pollution with Group A taxa being the most sensitive and Group E taxa being the most tolerant.

Group A – Sensitive
Group B – Less sensitive
Group C – Tolerant
Group D – Very tolerant
Group E – Most tolerant

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Q-values were assigned as per EPA published guidance (McGarrigle *et al.*, 2002; Toner *et al.*, 2005) with the surveyor taking into account river typology, seasonality and habitat conditions as per EPA guidance The information collected during the general river habitat characteristic survey was used to inform Q-value assignment.

The Q-value mainly reflects the effects of organic pollution (i.e., deoxygenation and eutrophication) but where a toxic effect is apparent or suspected the suffix '0' is added to the biotic index (e.g., Q1/0, 2/0 or 3/0). An asterisk after the Q value (e.g., Q3*) indicates heavy siltation of the substratum.

2.2.4. Aquatic plant observations

Any aquatic macrophytes observed were recorded and percentage cover noted. This included submerged/ emergent plants and those growing along the bankside. In addition, the percentage cover of any macroalgae, bryophytes and liverworts were also recorded. Plants and algae were identified to the lowest taxonomic level possible in the field.

2.2.5. Invasive plant species

Any invasive aquatic or riparian plants listed on the Third schedule of the EC (Birds and Natural Habitats) Regulations 2011 (S.I.477/2011) were noted.

2.2.6. Other species / features of note

The presence or signs of Annex I habitat or Annex II species or other protected species if present were noted such as those protected under the Wildlife Act 1976 (as amended), Flora Protection Order 1980 (as amended) or any other species or habitats that are rare.

2.3. Biosecurity

For all freshwater ecological surveys, the surveyor employs strict biosecurity methodology. The surveyor is familiar with invasive plant and animal species that occur in Ireland and before any site is visited a review of any aquatic or terrestrial invasive species records is conducted using the National Biodiversity Data Centres (NBDC) online mapping tool to assist in biosecurity planning. Once on site, should any invasive plant species be present their location is recorded and disturbance of the area avoided.

The surveyor employs the Check – Clean – Dry protocol as recommended by Inland Fisheries Ireland. Before leaving the sampling site all equipment (waders, nets, buckets, trays etc) are checked and any visible debris removed. Equipment is then cleaned using a solution approved for use near water and recommended dosage (Virkon® Aquatic). All equipment is then stored and allowed to dry thoroughly

before reuse. The surveyor holds a second set of gear which is used if sampling more than one catchment in a day.

The surveyor is aware of the current outbreak of crayfish plague (*Aphanomyces astaci*) which is easily spread on contaminated equipment. The latest advice on sampling rivers with known outbreaks will be adhered to. Should there be multiple sites on the same watercourse the surveyor will start in the upper reaches to avoid transmission in an upstream direction. All the equipment will be treated appropriately before re-use, in some cases a second set of clean equipment may be used. Any signs of crayfish plague will be reported immediately to relevant authorities.

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3. BIOLOGICAL RESULTS

Section 3.1 discusses the results of the desktop study and known existing biological water quality. **Section 3.2** and **Section 3.3** discusses the results of the biological (macroinvertebrate) monitoring for Derryclare and Caphaghoosh respectively.

An overall summary for each property is given at the start of each section and then each site is discussed individually for more detail. Please see **Appendix A** for summary tables of the general conditions observed at each site as well as a breakdown of the macroinvertebrates identified.

3.1. Existing Biological Water Quality

The biological monitoring sites are located in remote areas which are difficult to access. While the EPA monitor a vast network of rivers in Ireland the majority of the rivers in this project are not monitored individually by the EPA. Instead, rivers which are considered to have similar characteristics are grouped together by the EPA into one waterbody. This means that one waterbody can consist of several individual rivers which are not connected to each other but have similar characteristics. One of the rivers in this waterbody will be monitored and then a status is applied which encompasses all the rivers that fall into that waterbody.

There is an EPA biological monitoring station on the Recess_010 approximately 514m upstream of sample site CB-B and site CB-A is also located on this river. A Q4 was assigned indicating Good biological quality in 2021. However, the overall WFD Status is Moderate due to supporting chemistry conditions and previous moderate biological quality within the monitoring cycle. This river waterbody is At Risk of failing to achieve WFD objectives (2016-2021). The characterisation process for the 3rd Cycle RBMP has been completed for the Galway Bay North catchment by the EPA (EPA, 2021). As part of this process significant pressures are assigned to waterbodies which are At Risk. Significant pressure assigned to the Recess_010 is; Agriculture (chemical pollution as a result of sheep dip).

For the Recess_020 waterbody there are no EPA monitoring points at all. In this case a WFD status is based on modelling and High WFD status (2016-2021) has been assigned. Monitoring sites DB-1 to DB-6 are all located within this waterbody.

For the Invermore_010 there is an EPA biological monitoring station at sample site CB-E upstream of Invermore Lough. A Q3-4 indicating Moderate biological quality was assigned in 2021 and the waterbody has been assigned Moderate WFD Status (2016-2021). The waterbody is At Risk of failing to achieve WFD objectives. The significant pressure assigned to this waterbody is; Forestry (including clear felling and associated drainage). Sample sites CB-D is located upstream of the EPA monitoring point.

Finally, for Invermore_020 there is an EPA biological monitoring station at the outlet of Invermore Lough. Sample point CB-C is on this waterbody but in a separate stream. At the EPA monitoring point a Q3 indicating Poor biological quality was assigned in 2021 and the waterbody has been assigned Poor WFD Status (2016-2021), the river is At Risk of failing to achieve WFD objectives. The significant pressures assigned to this waterbody are; Domestic wastewater, Forestry and Peat extraction & drainage.

Figure 3-1: Modelled WFD Status (2016-2021) for Derryclare.

Figure 3-2: WFD status (2016-2021) and most recent EPA Q-values for Cappaghoosh.

Table 3-1: WFD Status 2016-2021 (*status is based on modelling).

Site code	Property	EPA waterbody name	WFD Code	WFD Status	WFD Risk (3rd Cycle)
DB-1 to DB-6 P1 to P4	Derryclare	Recess_020	IE_WE_31R010500	High*	Not at risk
P5	Derryclare	Lough Inagh	IE_WE_31_232	High	Not at risk
CB-A, CB-B	Cappaghoosh	Recess_010	IE_WE_31R010400	Moderate	At risk
CB-C C1 to C14, C18	Cappaghoosh	Invermore_020	IE_WE_31I010500	Poor	At risk
CB-D, CB-E C15 to C17	Cappaghoosh	Invermore_010	IE_WE_31I010080	Moderate	At risk

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Table 3-2: Summary of EPA Q-value results for the last three EPA monitoring cycles.

Water body name	WFD code	EPA station code & name	Closest Sample site	EPA Q-value
Recess_010	IE_WE_31R010400	31R010100 Bunskannive Bridge	CB-A	Q3-4 (2019) Q3-4 (2020) Q4 (2021)
Invermore_010	IE_WE_31I010080	31I010080 0.4km d/s L Bunnahask	CB-E	Q3 (2015) Q3-4 (2018) Q3-4 (2021)

3.2. Derryclare

The results of the biological (macroinvertebrate) monitoring for the six sites in Derryclare are presented in **Table 3-3** below. In summary, sites DB-1 and DB-5 were not suitable to conduct a Q-value assessment. These were very deep rivers (>1m) with peaty substrate and stagnant water. In addition, there was no marginal vegetation to take a sweep sample.

Macroinvertebrate sampling was possible at the remaining sites and Q-value result ranged from High (Q4-5) to Moderate (Q3-4). All the rivers surveyed are part of the Recess_020 waterbody. The EPA have modelled this waterbody as having High WFD Status but it is not monitored directly. The results of this survey indicates that only one of the rivers is achieving High biological quality. This river was only just achieving High quality in the upper reaches but further downstream it declined to Good. A Q3-4 was assigned at one site indicating unsatisfactory condition and a big departure from the expected High biological quality.

Table 3-3: Q-value results for Derryclare site in 2023.

Site code	Q-value (2023)
DB-1	n/a
DB-2	Q3-4 (Moderate)
DB-3	Q4 (Good)
DB-4	Q4-5 (High)
DB-5	n/a
DB-6	Q4 (Good)

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3.2.1. Site DB-1

This is small river system which rises within the Derryclare property in a small block of coniferous forestry. As the river flows downstream it enters an area where clear felling has taken place. From Google Earth aerial imagery it appears this was conducted >10 years ago. Habitat has begun to vegetate with regenerating conifers/broadleaves but largely remains open and unshaded along the river. At the sampling point the river here is narrow (0.3m) and very deep (>1m). There was no perceptible flow and water was highly coloured. The river substrate was peaty and it was not possible to enter the water to take a macroinvertebrate sample.

Given the conditions observed this river was unsuitable to take a macroinvertebrate sample and conduct a Q-value assessment. The Q-value was not developed for stagnant peaty rivers and therefore

cannot be applied. There was no marginal aquatic vegetation to even take a sweep sample for macroinvertebrates. The river here is more characteristic of a linear bog pool than a flowing river.

Further downstream the river enters the boundary of the Derryclare Nature Reserve and flows through a section of willow/birch woodland before entering a small lake in the reserve. The river then leaves the lake and flows toward Derryclare Lough. In this section, the river has widened slightly but still very deep with pond like conditions supporting numerous dragonflies and damselflies -brown hawker (*Aeshna grandis*) and large red damselfly (*Ischnura elegans*) were two species identified.

On the day of survey dissolved oxygen was very low (30%, 2.63mg/l) but not unexpected given there is little opportunity for aeration in this stagnant river. Water temperatures were quite high at 23°C and pH was 6 indicating slight acidic conditions.

No aquatic vegetation was observed growing within the river. Water was very dark and deep with no shallow margins making conditions difficult for rooted aquatic species to grow but also survey. Bankside vegetation consisted of lesser spearwort (*Ranunculus flammula*), *Sphagnum* sp., cross-leaved heath (*Erica tetralix*), cuckoo flower (*Cardamine pratensis*), bog cotton (*Eriophorum angustifolium*), rushes (*Juncus* sp., common marsh-bedstraw (*Galium palustre*). Young recolonising conifers and birch were scattered across the clear-felled areas. Beard lichen (*Usnea* sp.) was present on some of the birch and willow trees, this is a lichen that would indicate clean air as it is intolerant of air pollution.

Just upstream of Derryclare Lough a forestry road crosses the river. This bridge spans large boulders placed in the river and it is unclear whether there is a pipe culvert to convey water or if water is dammed by the boulders as vegetation growth was thick here. Flow was stagnant on both sides of the bridge. The bridge is a potential barrier for the movement of aquatic species and it is recommended to investigate this further and assess whether remediation is required.

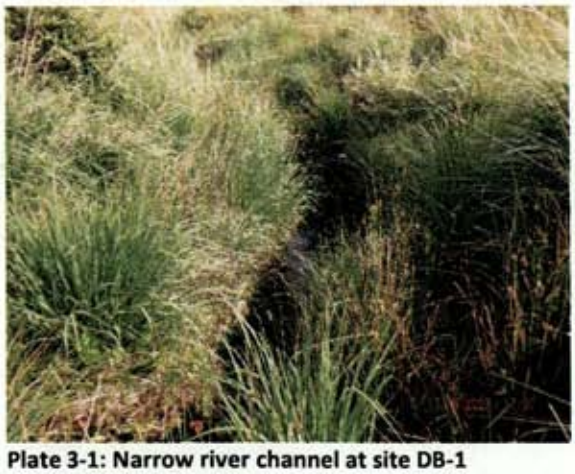

Plate 3-1: Narrow river channel at site DB-1

Plate 3-2: River channel downstream of site DB-1 and the small lake. Here the channel is slightly wider but still deep and stagnant.

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3.2.2. Site DB-2

This site is located just on the boundary of the Derryclare Nature Reserve. At the time of survey water levels were very low (0.1m) and the river had a wetted width of 1m but it was clear the bankfull width in higher flows is much wider (2.5m). The flow velocity was slow at the time of survey and moderate water colour.

The river substrate was bedrock and boulder dominated with pockets of smaller substrate and no siltation observed. Owing to the low water the river habitat consisted mainly of glide with no riffles but some pools were present. It is clear that in higher flows this would be a more energetic river with riffles and small cascades down the bedrock.

The river channel appeared natural with no signs of anthropogenic interference at the sample site. Coniferous forestry is present directly upstream with some recent felling activity along the upper reaches of this river (between 2021 -2023 on Google Earth aerial imagery). At the sample site there is an excellent wide broadleaved riparian buffer (>100m). The woodland here is dominated with oak (*Quercus* sp.) but also contains some birch (*Betula* sp.), rowan (*Sorbus aucuparia*), holly (*Ilex aquifolium*), hawthorn (*Crataegus monogyna*) and willow (*Salix* sp.). In more open areas bog/heathland plant species were present such as *Sphagnum* sp., bog asphodel (*Narthecium ossifragum*) tormentil (*Potentilla erecta*) and ling (*Calluna vulgaris*).

The leafy liverwort (*Marsupella* sp.) was the only aquatic plant identified which was growing on the boulders (60% coverage). On the day of survey oxygen and conductivity readings were considered to be within the normal range and as expected for this river. pH was 5.57 indicating acidic conditions.

Upstream of the sample site the river flows under a forestry road via a concrete box culvert. On the day of survey this culvert was perched 0.6m above the river and completely dry. Water was instead flowing under the culvert. These conditions form a barrier for the movement of aquatic species and it is recommended that remediation is investigated.

The macroinvertebrate kick sample indicated a low taxon richness with 13 taxa recorded. Two pollution sensitive taxa (Group A) were present but in low numbers. These were both stoneflies in the Nemouridae family (*Protonemura* sp. and *Amphinemura* sp.). A few *Protonemura* sp. were present and only a single specimen of *Amphinemura* sp. was found. Only one Group B taxon was present which was the mayfly, Leptophlebidae, in small numbers. Most of the sample was made up of pollution tolerant taxa (Group C). Chironomidae and Simuliidae were numerous and the caseless caddisfly Polycentropodidae common. The remaining taxa were present in few numbers. No Group D or E taxa were present.

Although two Group A taxa were found one was in low numbers and the other was a single specimen. Single specimens are not counted toward the Q-value. Only one Group B was present and the sample appeared unbalanced with Chironomidae and Simuliidae being abundant. For these reasons a Q3-4 was assigned indicating Moderate biological quality. It must be noted that this river is dominated with bedrock and boulders, in normal flow conditions finding areas with loose substrate would be tricky but in the very low water levels observed this was even more difficult. It would be interesting to see if the Q-value score improves in higher flows. The low pH recorded on the day of survey indicates acidic conditions and would explain the lack of acid sensitive taxa such as *Baetis rhodani*, Hydrophyscidae.

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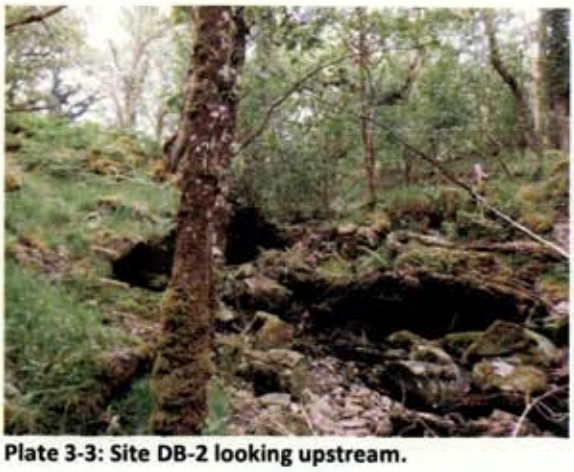

Plate 3-3: Site DB-2 looking upstream.

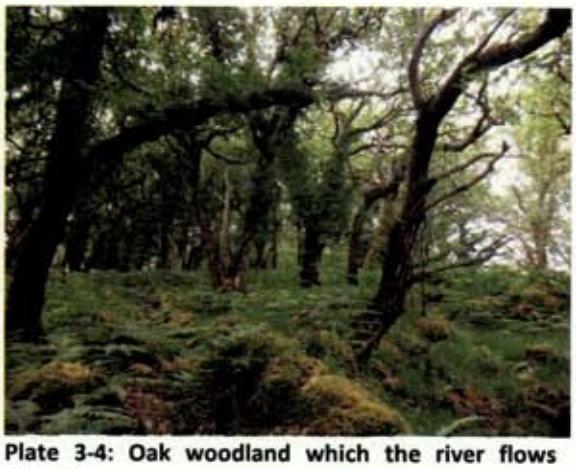

Plate 3-4: Oak woodland which the river flows through.

Plate 3-5: Macroinvertebrate sample taken at site DB-2.

Plate 3-6: Dry box culvert upstream of site DB-2.

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3.2.3. Site DB-3

Site DB-3 is located on the same river as site DB-4 in the lower reaches of the river just upstream of Lough Inagh. The middle and lower reaches of this river flow entirely through mature coniferous forestry. Water levels were low at time of survey (0.1m) with short sections almost dry. Wetted width was approximately 2m. River substrate is boulder / cobble dominated with some coarse gravels, sand and no siltation recorded. The river channel itself appeared natural with no anthropogenic interference.

At the time of survey flow velocity was slow and with such low water a relatively uniform glide habitat was present. However, it was clear there would be a well-developed riffle/glide/pool sequence in higher flows. A narrow riparian zone (10m) was present but in some sections this zone was absent with coniferous trees planted to the edge of both banks. Bankside vegetation consisted of regenerating and mature conifers, gorse (*Ulex europaeus*), *Sphagnum* sp., tormentil (*Potentilla erecta*), rushes (*Juncus* sp.), foxglove (*Digitalis purpurea*). The invasive species Rhododendron was also present.

On the day of survey dissolved oxygen levels were low 85.9% and 7.93mg/l which is not surprising given the depth of water. The pH recorded was very low at pH 4.76 indicating acidic conditions.

Aquatic vegetation consisted of the algae; Batrachospermum (<1%) and slimy filamentous green algae (10%).

The macroinvertebrate sample indicated low richness with 12 taxa present. Three pollution sensitive (Group A) taxa were present in the sample. Of these the flattened mayfly, *Electrogena* sp. was common and two stoneflies Chloroperlidae and *Protonemura* sp. were present in few numbers. One less sensitive taxon was common (Group B) and this was the stonefly (*Leuctra* sp.). Simuliidae (Group C) were numerous. The remainder of the sample was made up of pollution tolerant taxa (Group C) in low numbers and one Most tolerant (Group E) again in low numbers.

Interestingly the sample was generally made up of species moderately tolerant - tolerant of acidic conditions and this is reflective of the low pH observed. Three Group A's were present with one of these being common. The sample was slightly unbalanced with numerous Simuliidae and there was quite a bit of filamentous green algae on the substrate. A Q4 indicating Good biological quality was assigned. It would be interesting to see if the Q-value improves with higher water levels.

Plate 3-7: Site DB-3 facing upstream.

Plate 3-8: Site DB-3 facing downstream with L. Inagh just visible in background.

Plate 3-9: Typical substrate at site DB-3.

Plate 3-10: Macroinvertebrate sample taken at site DB-3.

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3.2.4. Site DB-4

This site is located 935m upstream of DB-3 in the middle reaches of the river. Here the river has just travelled down the mountains and it is steep, boulder dominated with bedrock outcrops. These characteristics have created a cascade-step-pool habitat. At the time of survey water depth was shallow (0.1m) with moderate flow velocity and a wetted width of 1m. Moderate bank erosion was observed but this was considered to be mainly natural in this energetic stream (in higher flows). Some areas of bank erosion due to sheep/deer access was also visible. No siltation of the substrate was noted.

A narrow riparian buffer was present (10m) but in some sections this zone was absent with coniferous trees planted to the bank edge. Upstream of the bridge on the right bank there is an area which has been clearfelled (sometime between 2017 -2020 from Google Earth imagery). Bankside vegetation consist mainly of conifers but in more open sections and clearfelled areas there is; bell heather (*Erica cinerea*), tormentil (*Potentilla erecta*), rushes (*Juncus* sp.), foxglove (*Digitalis purpurea*), bird's-foot trefoil (*Lotus corniculatus*), meadowsweet (*Filipendula ulmaria*) and regenerating confiers. There were also occasional willow trees (*Salix* sp.).

Slimy filamentous green alga was present instream covering 20% of the substrate and no other aquatic vegetation was visible. Dissolved oxygen conditions were within normal range and pH was much higher (pH 6.25) compared to the downstream site (pH 4.76).

The macroinvertebrate sample indicated a very low diversity with only 9 taxa recorded. Despite this, two pollution sensitive taxa were recorded in good numbers with the flattened mayfly, *Electrogena* sp. were numerous and stonefly *Amphinemura* sp. were common. One less-sensitive taxon was recorded in low numbers which was the stonefly, *Leuctra* sp. The remaining sample was made up of tolerant taxa (Group C) in few numbers with Simuliidae being common. Water was low at the time of survey and substrate was dominated with boulders, these conditions made it difficult to find suitable spots with loose substrate to sample. Although richness was low, two Group A's were in good numbers and taking the low water into account a Q4-5 was assigned. This would indicate High biological quality but it is considered that the site is just on the boundary between Good and High.

Plate 3-11: Site DB-4 facing downstream

Plate 3-12: Bridge at site DB-4 facing upstream.

Plate 3-13: Land use directly upstream of site DB-4

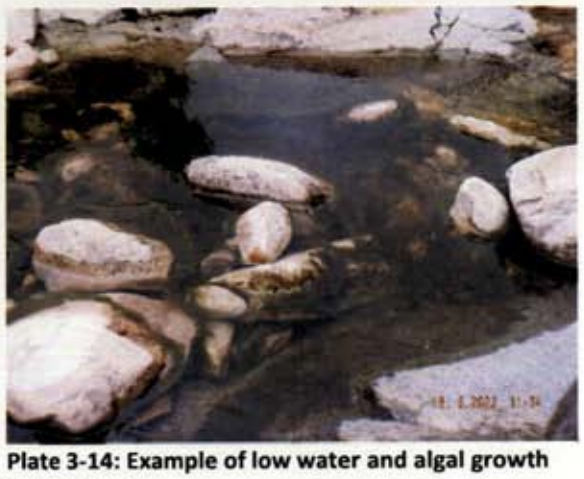

Plate 3-14: Example of low water and algal growth in the river.

3.2.5. Site DB-5

This is a short river system rising within the Derryclare property and flowing entirely through coniferous forestry. The site is located just upstream of the outlet to Lough Inagh. Here the river is narrow (1m), very deep (>1m) with vertical 1m high banks. The water was highly coloured with no perceptible flow and an oily sheen on the surface formed by bacteria. River bed substrate was very peaty and soft. The deep water and soft substrate meant it was not possible to enter the water to take a macroinvertebrate sample.

Given the conditions observed the river was unsuitable to conduct a macroinvertebrate sample and Q-value assessment. The Q-value was not developed for stagnant peaty rivers and therefore cannot be applied. There was no marginal aquatic vegetation to even take a sweep sample for macroinvertebrates.

The river here is located within coniferous forestry with trees planted close to bank edge (within 3m) in some places. This has created a dark habitat shading the river. Bankside habitat consisted mainly of grasses and rushes with some young conifers and the invasive Rhododendron also present. The aquatic plant water lobelia (*Lobelia dortmanna*) was present along the shoreline of the lake. This plant is typical growing in shallow waters of oligotrophic lakes on acid stony substrates.

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The river here appears to have been modified into a drainage channel with straightening and deepening. Near the outlet to the lake the river becomes shallower and almost half the channel was covered in slimy filamentous green algae (40%). Dissolved oxygen readings were high (141% 13mg/l) likely due to the excessive algae creating super saturated conditions during the day. pH was low at 5.4 indicating slightly acidic conditions.

Plate 3-15: Straightened channel at site DB-5

Plate 3-16: Stagnant water at site DB-5 with Rhododendron visible in the background.

Plate 3-17: River entering L. Inagh

Plate 3-18: Water lobella in flower along shoreline of L. Inagh

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3.2.6. Site DB-6

This river is located just outside the northern boundary of the Derryclare property. At the sample site the river had a wetted and bankfull width of 1.5m with 0.3m high banks. Water was moderately coloured and very shallow on the day of survey (0.07m) but there was still a good riffle/ glide sequence with pools also present.

Moderate bank erosion with undercutting was visible and considered mostly natural however at some locations it was clear erosion was due to sheep/deer access. Along the left bank the river here flows through open expanse of heathland/ blanket bog with bankside vegetation consisting of cross-leaved heath (*Erica tetralix*), bell heather (*Erica cinerea*), *Sphagnum* sp., bog asphodel (*Narthecium ossifragum*), tormentil (*Potentilla erecta*), bog myrtle (*Myrica gale*), bog cotton (*Eriophorum angustifolium*) and rushes (*Juncus* sp.). Habitat is similar on the right bank with an area of clear fell 15-80m back from the bank. It is unclear when this area was felled but it has revegetated with some conifers and broadleaved trees present.

Substrate was cobble dominated with low surface siltation observed (2% silt coverage). A fair bit of slimy green filamentous algae (25%) was observed growing on the cobble substrate. While such a large amount of algae can indicate nutrient enrichment it should be noted that the low flows, cobble substrate and open sunny habitat also create ideal growing conditions for algae at this time of year. The algae Batrachospermum (<1%) and leafy liverwort *Marsupella* sp. were the only other aquatic vegetation present (2%).

The macroinvertebrate sample indicated low taxon richness with 12 taxa present. Three pollution sensitive taxa were present. Of these the stoneflies, *Isoperla grammatica* and *Chloroperlidae* were common and the flatten mayfly *Electrogena* sp. occurred in few numbers. One less sensitive taxon (*Leuctra* sp.) was also common. The remainder of the sample was made up of tolerant taxa (Group C) with numerous Simuliidae present.

With two Group A's common the sample is very close to a Q4-5 (High) however with numerous Simuliidae the sample is a little unbalanced and it is pushed to a Q4 indicating Good biological quality. As with the other rivers in this survey it will be interesting to see whether the Q-value improves in higher flows.

Plate 3-19: Site DB-6 facing upstream with forestry just visible in background.

Plate 3-20: Site DB-6 facing downstream.

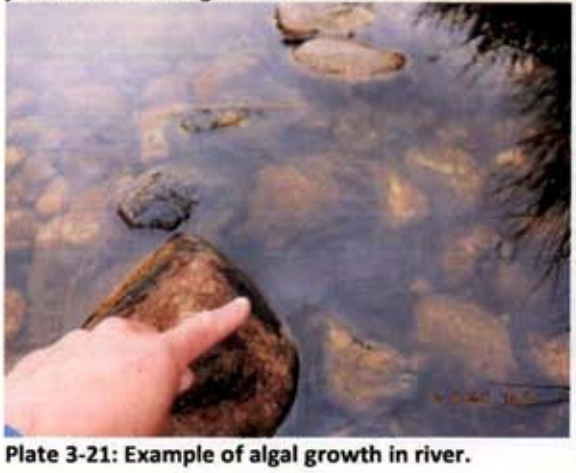

Plate 3-21: Example of algal growth in river.

Plate 3-22: Macroinvertebrate sample taken at site.

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3.3. Cappaghoosh

The results of the biological (macroinvertebrate) survey for the six sites in Cappaghoosh are presented in **Table 3-4** below. In summary, sites CB-C and CB-D were not suitable to conduct a Q-value assessment. The first was completely dry on the day of survey and the second site was very slow and deep with pond like conditions.

Of the sites that were surveyed only one achieved satisfactory condition with a Q4 (Good) assigned. This was site CB-A downstream of a small parcel of mature forestry. Further upstream in the same river the conditions degraded to a Q3-4. The lowest biological water quality across both properties was recorded at site CB-E. Here a Q3 was assigned indicating Poor biological quality. This is also an EPA monitoring point and historic results indicate that this river struggles to reach satisfactory condition and has not received a Q4 since 2003.

Table 3-4: Q-value results Cappaghoosh sites in 2023.

Site code	Q-value (2023)
CB-A	Q4 (Good)
CB-B	Q3-4 (Moderate)
CB-C	n/a
CB-D	n/a
CB-E	Q3 (Poor)

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3.3.1. Site CB-A

This site is located on the Recess_010 waterbody also known as the Caher/Owentooey river. The site is directly downstream a small parcel of coniferous forestry. This is a much larger river compared to the Derryclare rivers (7m wetted width) and although water levels were low there was a greater depth (0.3m) than the rivers in Derryclare. Flow velocity was slow to moderate and the river channel appeared natural with meanders and well-developed riffle glide pool sequence. Some bank erosion was evident with sheep accessing the river.

This is a cobble dominated stream with some siltation of the substrate observed (5%) and a moderate plume of silt was generated when the substrate was disturbed indicating siltation within the interstices of the substrate. Along the right bank there is a continuous and wide (50m) riparian treeline consisting of willow (*Salix* sp.) and alder (*Alnus glutinosa*). These trees overhang the bank creating light shading. The left bank is open with heathland species; bog myrtle (*Myrica gale*), rushes (*Juncus* sp.), dog rose (*Rosa canina*), cross-leaved heath (*Erica tetralix*), ling (*Calluna vulgaris*) gorse (*Ulex europaeus*), bog asphodel (*Narthecium ossifragum*) and bog cotton (*Eriophorum angustifolium*) with sheep grazing here.

There was a moderate amount of filamentous green algae covering the substrate within the river (30%). Other aquatic plants identified included; watermilfoil (*Myriophylum* sp.) lesser spearwort (*Ranunculus flammula*), pondweed (*Potamogeton* sp) and water lobelia (*Lobelia dortmanna*) was flowering along the bank edges.

The macroinvertebrate sample indicated moderate taxon richness with 15 taxa present. Two pollution sensitive (Group A) taxa were present with the flattened mayfly (*Heptagenia* sp.) common and the stonefly (*Isoperla grammatica*) occurring in few numbers. Three less sensitive (Group B) taxa were present and all were cased-caddisflies. Tolerant taxa (Group C) made up most of the sample with

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Chironomidae being numerous while *Baetis rhodani/atlanticus* was common, Very tolerant (Group D) and Most tolerant taxa (Group E) only occurred in low numbers. As one Group A was common with a number of cased caddis also present a Q4 was assigned indicating Good biological quality.

Plate 3-23: Site CB-A facing upstream.

Plate 3-24: Site CB-A facing downstream with continuous treeline visible along the right bank.

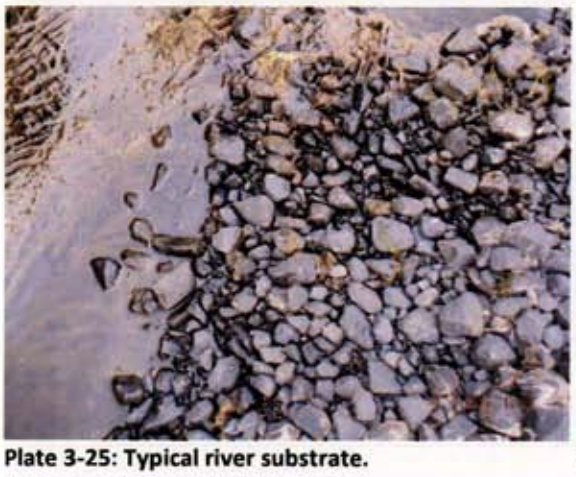

Plate 3-25: Typical river substrate.

Plate 3-26: Alga covering substrate.

3.3.2. Site CB-B

This site is upstream of CB-A and located 150m downstream of Tawnagh Lough. The river here is slow moving with a wetted width of 5m and shallow depth at time of survey (0.2m). Habitat is mostly a slow glide but there is a small amount of riffle where boulders span across the river channel. These boulders appear to be artificially placed as they are spaced at intervals downs the river channel. Moderate bank erosion was evident with sheep accessing the river.

Substrate was cobble/ coarse gravel dominated with bedrock outcrops in sections. Some siltation of the substrate observed (5%) and a moderate plume of silt was generated when the substrate was disturbed indicating siltation within the interstices of the substrate. A limited riparian buffer was present with a narrow 1m willow treeline along the right bank. Along the left bank sheep grazing on the heathland is present up to the bank edge, vegetation here consisted of; rushes (*Juncus* sp.), horsetail (*Equisetum* sp.), *Sphagnum* sp., bog myrtle (*Myrica gale*), tormentil (*Potentilla erecta*), cross-

leaved heath (*Erica tetralix*), forget-me-not (*Myosotis* sp.), bog asphodel (*Narthecium ossifragum*) bog cotton (*Eriophorum angustifolium*) and common marsh-bedstraw (*Galium palustre*).

Dissolved oxygen was low at the time of survey (78.6%, 6.85mg/l). Instream vegetation consisted of a fair amount of filamentous green algae (20%), watermilfoil (*Myriophylum* sp.), lesser spearwort (*Ranunculus flammula*), pondweed (*Potamogeton* sp.), water-starwort (*Callitriche* sp.) and water mint (*Mentha aquatica*).

The macroinvertebrate sample indicated moderate taxon richness with 15 taxa present. Two pollution sensitive (Group A) taxa were present but in very low numbers. Only two specimens of the flattened mayfly (*Heptagenia* sp.) and two of the stonefly (*Isoperla grammatica*) were present. Two less sensitive taxa were present but again in few numbers (*Leuctra* sp. and Sericostomatidae). Pollution tolerant (Group C) taxa made up the majority of the sample with Simuliidae numerous while *Baetis rhodani/atlanticus* and *Seretella ignita* were both common. The very tolerant (Group D) bivalve *Pisidium/Sphaerium* spp was also numerous.

Although two Group A's were present these were in very low numbers. Diversity and abundances appeared unbalanced and a Q3-4 was assigned indicating Moderate biological quality.

Plate 3-27: Site CB-B facing upstream

Plate 3-28: Site CB-B facing downstream.

Plate 3-29:Vegetation with the river.

Plate 3-30: Example of boulder weir across river.

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3.3.3. Site CB-C

This site is located on the Owengarve River just before it enters Lough Currell. This is a very isolated and remote site which is difficult to access on foot. The river here is very dark, deep with no flowing water. Aquatic vegetation consisted of both yellow and white water lilly (*Nuphar lutea* and *Nymphaea alba)* and *Sphagnum auriculatum* which was growing in large clumps submerged underwater. The conditions are more like a large bog pool than a river. The river was walked further upstream (c.200m) but conditions were similar.

Given these characteristics a Q-value could not be conducted. Of note was a sea eagle observed perched in the trees on an island within Lough Currell.

Plate 3-31: Site CB-C facing upstream.

3.3.4. Site CB-D

This river is mapped flowing toward Lough Duff. On the day of survey, no discernible river channel was identified. There is a wet flush around a small willow and conifer woodland area but a flowing stream could not be found. There are significant drainage channels around the mapped stream. To the north-east there is narrow drainage channel cut 1m down into the bog and this was almost dry. There is another very wide drainage channel to the south-west of the mapped stream. This is a 6m wide drainage channel with peat excavated to the subsoil and material piled onto the sides forming embankments which are now fully vegetated. This area was also dry with some puddles.

No survey was conducted at this site as no river could be found.

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Plate 3-32: Drainage channel to the north-east of the mapped river

Plate 3-33: Drainage channel to the south-west of the mapped river with soil excavated to the bedrock.

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3.3.5. Site CB-E

This site is located on a section of river between L. Bunnahask and L. Alligan. At the sample location chosen via desktop analysis it was not possible to conduct a kick sample as the river substrate was dominated with bedrock. The site was moved a little further upstream to where there is also an EPA biological monitoring point.

At the site sampled the river had a 2m wetted width and 0.3m depth. Habitat was glide dominated with some pools and riffles. The substrate is dominated with large boulders, cobbles and coarse gravel. Some siltation was observed (5%) and low-moderate plume of silt was generated when the substrate was disturbed.

Open blanket bog and heathland are present along the left bank with vegetation consisting of, bog myrtle (*Myrica gale*), bog asphodel (*Narthecium ossifragum*), cross-leaved heath (*Erica tetralix*), ling (*Calluna vulgaris*), tormentil (*Potentilla erecta*) and butterfly orchid (*Platanthera sp.*). A narrow band (5m) of this habitat occurs along the right bank and then there is a forestry track and coniferous plantation.

Instream the substrate was almost entirely covered with the filamentous green alga, *Cladophora* sp. with 80% coverage. While such a large proportion of algae can indicate nutrient enrichment it should be noted that the low flows and open sunny habitat also create ideal growing conditions for algae at this time of year and it may be a combination of enrichment and channel conditions that resulted in the excessive algae. The macroalgae *Batrachospermum* sp. was also present in large quantities.

The keeled skimmer dragonfly was observed which is found along wet heathland areas.

The macroinvertebrate sample showed a very low diversity with only seven taxa present. No pollution sensitive (Group A) taxa were present. One less sensitive taxon was present in low numbers and this was the caseless caddis fly, Sericostomatidae. The sample was made up of tolerant taxa (Group C) with numerous Chironomidae Caseless caddisflies and Simuliidae were common. With no Group A taxa, low diversity and excessive algal growth a Q3 was assigned indicating Poor biological quality. The site was last sampled by the EPA in 2021 were a Q3-4 (moderate) was assigned and it appears there has been a decline in this river since. The river here has not achieved a Q4 (Good) since 2003.

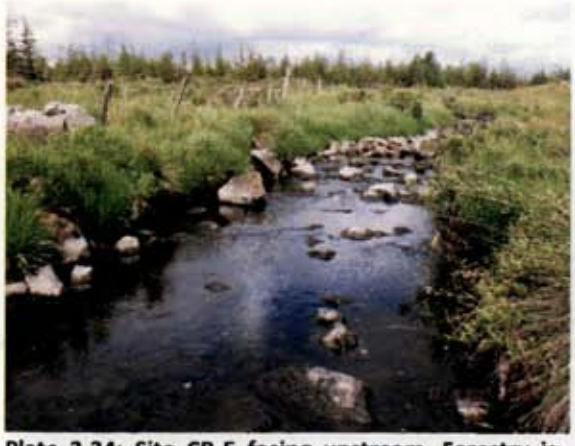

Plate 3-34: Site CB-E facing upstream. Forestry is visible in background.

Plate 3-35: Site CB-E facing downstream.

Plate 3-36: River substrate with excessive algal growth.

Plate 3-37: Macroinvertebrate sample.

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4. WATER CHEMSITRY RESULTS

In total 18 sites are sampled across the Derryclare and Cappaghoosh properties monthly. For each water sample 21 chemical parameters are analysed generating a large list of results. This section summarises the results from January to April for Derryclare and February to April for Cappaghoosh.

To help summarise the results succinctly each parameter was assessed against its assigned Ecological Quality Standard (EQS) as set out in the EU Surface Water Regulations (S.I. 77/2009 as amended). These standards are presented in **Table 4-1** below. The majority of these EQS's are based on an annual average over a 12-month period. As only 3-4 months data has been collected the comparison with the EQS serves as an initial guide only. Not all of the parameters analysed have a set EQS.

Significant results which appear to breech the EQS are discussed below. In addition, some sites are located on the same river. These sites are compared with each other and where differences worth highlighting are present they are discussed below. **Appendix B** presents graphs showing the general trend of results for the main parameters discussed.

Please note that dissolved oxygen results are not discussed as this parameter was measured in the laboratory at room temperature and not a reflection of the river conditions at time of survey.

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Table 4-1: Summary of parameters analysed at each site and corresponding EQS as per the Surface Water Regulations if one has been set.

Parameter	Surface Water Regs EQS
Alkalinity (mg/L $CaCO_3$)	-
Aluminium (µg/L)	-
Ammonia (mg/L as N)	High status ≤0.040 (mean) / ≤0.090 (95%ile) Good status ≤0.065 (mean) / ≤0.140 (95%ile) (Applies to rivers and lakes)
Calcium (mg/L)	-
Conductivity (at 20°C)	-
Copper (µg/L)	5 - water hardness ≤100mg/L $CaCO^3$ 30 - water hardness ≥100mg/L $CaCO^3$ Annual average EQS - for each representative monitoring point within the waterbody, the arithmetic mean of the concentrations measured over a twelvemonth monitoring period does not exceed the standard. (Applies to rivers and lakes)
Dissolved Organic Carbon (mg/L)	-
Dissolved oxygen (mg/L)	Lower limit 95%ile >80% saturation Upper limit 95%ile <120% saturation (Applied to rivers and lakes)
Hardness Total (mg/L $CaCO_3$)	-
Iron (µg/L)	-
Magnesium (mg/L)	-
Manganese (µg/L)	-
Nickel (µg/L)	20 Expressed as an annual average value. Unless otherwise specified, it applies to the total concentration of all isomers. (Applied to rivers and lakes)
Nitrate (mg/L as N)	-
pH (pH Units)	Soft waters (≤100mg/L $CaCO_3$) >4.5 <9 Hard waters (>100mg/L $CaCO_3$) >6 <9 (Applies to rivers and lakes)
Phosphate-Ortho (mg/L)	High status ≤0.025 (mean) / ≤0.045 (95%ile) Good status ≤0.035 (mean) / ≤0.075 (95%ile) (Applies to rivers only and is for MRP)
Phosphorus-Total (mg/L as P)	High status ≤0.010 (mean) Good status ≤0.025 (mean) (Applies to lakes only and is for MRP)
Potassium (mg/L)	-
Sodium (mg/L)	-
Solids-Total Suspended (mg/L)	No EQS but standard stipulated within the Salmonid regulations is often uses as a standard for suspended solids. ≤25 mg/L (Annual average over 12 months)
Zinc (µg/L)	8 - water hardness annual average ≤10mg/L $CaCO^3$ 50 - water hardness annual average >10 to ≤100mg/L $CaCO^3$ 100 - water hardness annual average >100mg/L $CaCO^3$ (Annual average EQS - for each representative monitoring point within the waterbody, the arithmetic mean of the concentrations measured over 12 month monitoring period does not exceed the standard)

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4.1. Derryclare

4.1.1. Sites P1 & P2

Sample site P1 is located on the boundary of the Derryclare property and is just upstream of the forestry. Sample P2 is located downstream in the lower reaches after the river has flowed through the forestry and just before it enters L. Inagh.

The average results across all four months for both sites are presented below in **Table 4-2.** In general, this river has low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating acidic conditions.

Most parameters are similar across both sites but levels of aluminium, iron and manganese are much higher in all months at the downstream site P2 indicating leaching of metals. In addition, dissolved organic carbon is higher at P2 in all months.

Levels of zinc exceed the EQS (8mg/L for waters with annual average hardness ≤10mg/L $CaCO_3$). The spike in zinc levels occurred in February and March. It must be noted that this EQS is based on an annual average of 12 months data and the results are for 4 months of data.

All other parameters which have an EQS set conform to these standards set. Mean ammonia and ortho-P levels indicate High nutrient status at both sites. pH levels indicate acidic conditions at both sites with levels toward the lower end of the EQS boundary. The lowest pH recorded was 4.87 in January and February at site P2.

Table 4-2: Average results (January- April) for paramaters measured at Sites P1 & P2. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	P1	P2
Alkalinity (mg/L $CaCO_3$)	8.00	4.67
Aluminium (µg/L)	54.25	78.50
Ammonia (mg/L as N)	0.02	0.03
Calcium (mg/L)	All samples below LOD <0.6	All samples below LOD <0.6
Conductivity (at 20°C)	38.625	43.3
Copper (µg/L)	All samples below LOD <0.002	All samples below LOD <0.002
Dissolved Organic Carbon (mg/L)	2.98	4.35
Hardness Total (mg/L $CaCO_3$)	8.00	6.25
Iron (µg/L)	25.75	107.25
Magnesium (mg/L)	0.60	0.65
Manganese (µg/L)	2.00	10.75
Nickel (µg/L)	All samples below LOD <1	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51	All samples below LOD <0.51
pH (pH Units)	5.21	4.94
Phosphate-Ortho (mg/L)	0.01	All samples below LOD <0.01
Phosphorus-Total (mg/L as P)	0.015	All samples below LOD <0.03
Potassium (mg/L)	0.30	0.28
Sodium (mg/L)	5.38	6.18
Solids-Total Suspended (mg/L)	All samples below LOD <2*	All samples below LOD <2*
Zinc (µg/L)	9.25	9

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

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4.1.2. Sites P3 & P4

Sample site P3 is located on the boundary of the property. It is in the upper reaches of the waterbody in a small tributary on the slopes of Derryclare mountain and upstream of the forestry. Sample P4 is located downstream in the lower reaches within the forestry.

The average results across all four months for both sites are presented below in **Table 4-3**. In general, this river has low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating acidic conditions.

Most parameters are similar across both sites but levels of aluminium, iron and manganese are again much higher in all months at the downstream site (P4) indicating leaching of metals. In addition, dissolved organic carbon is higher at P5 in all months.

Levels of zinc exceed the EQS (8mg/L for waters with hardness ≤10mg/L $CaCO_3$). The highest spike in zinc levels for both sites occurred in March. It must be noted that this EQS is based on an annual average of 12 months data and the results are for 4 months of data.

All other parameters which have an EQS set conform to these standards. Mean ortho-P levels indicate High status at both sites. Mean ammonia levels indicate High status at P3 and Good status at P4 but its only just missed achieving High. pH levels indicate acidic conditions at both sites with levels just within the lower EQS boundary. The lowest pH recorded was 4.65 in January at site P4.

Table 4-3: Average results (January- April) for paramaters measured at sites P3 & P4. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	P3	P4
Alkalinity (mg/L $CaCO_3$)	8.5	9
Aluminium (µg/L)	42	109.5
Ammonia (mg/L as N)	0.02	0.05
Calcium (mg/L)	All samples below LOD <0.6	0.6
Conductivity (at 20°C)	45.9	52.075
Copper (µg/L)	All samples below LOD <0.002	All samples below LOD <0.002
Dissolved Organic Carbon (mg/L)	3.75	7.8
Hardness Total (mg/L $CaCO_3$)	7.25	7
Iron (µg/L)	22.25	150.25
Magnesium (mg/L)	0.75	0.8
Manganese (µg/L)	2	13.75
Nickel (µg/L)	All samples below LOD <1	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51	All samples below LOD <0.51
pH (pH Units)	4.925	4.8775
Phosphate-Ortho (mg/L)	All samples below LOD <0.01	0.01
Phosphorus-Total (mg/L as P)	All samples below LOD <0.03	0.03
Potassium (mg/L)	0.325	0.55
Sodium (mg/L)	6.475	7.5
Solids-Total Suspended (mg/L)	4*	All samples below LOD <2*
Zinc (µg/L)	8.75	13.25

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

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4.1.3. Sites P5

This site is located within L. Inagh. In general, this lake has low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating slightly acidic conditions.

The average results across all four months for the sites are presented in **Table 4-4** below. Lough Inagh is a naturally oligotrophic (low nutrient) lake and the WFD objective of High status applies for the nutrients; ammonia and total-P. The mean results for ammonia indicate that this High status has been achieved. For total-P the laboratory limit of detection was 0.03mg/l which is above the EQS for both High and Good status. All samples were below the limit of detection and therefore it is not possible to tell which status band the samples fall into.

Table 4-4: Average results (January- April) for paramaters measured at site P5. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	P5
Alkalinity (mg/L $CaCO_3$)	11.5
Aluminium (µg/L)	43.5
Ammonia (mg/L as N)	0.023
Calcium (mg/L)	1.9
Conductivity (at 20°C)	52.43
Copper (µg/L)	All samples below LOD <0.002
Dissolved Organic Carbon (mg/L)	4.15
Hardness Total (mg/L $CaCO_3$)	9.75
Iron (µg/L)	153.5
Magnesium (mg/L)	0.925
Manganese (µg/L)	16.5
Nickel (µg/L)	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51
pH (pH Units)	6.09
Phosphate-Ortho (mg/L)	All samples below LOD <0.01
Phosphorus-Total (mg/L as P)	All samples below LOD <0.03
Potassium (mg/L)	0.35
Sodium (mg/L)	7.23
Solids-Total Suspended (mg/L)	5*
Zinc (µg/L)	19.67

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

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4.2. Cappaghoosh

4.2.1. Sites C2, C8, C5 & C4

The sites are located in the north-eastern section of Cappaghoosh. The rivers flow in an east-west direction through a number of lakes. Sites C8 is located just upstream of the property boundary and upstream of any forestry. It is located on separate river channel to the other sites and flows into L. Agay. This is a first order stream which rises only a short distance upstream. Here the river flows across

open blanket bog / heath and in effect represent conditions before the river flows through afforested areas.

Site C2 is also located on the property boundary the river here rises just upstream and flows mainly across open blanket peat / heathland. A small section borders forestry which from Google Earth imagery was felled sometime between 2009-2012 and replanted. The sample site is located downstream of this forestry. This channel then enters L. Mongaun and flows toward L. Agay. Site C5 is located just upstream of the latter lake. The channel leaves L.Agay and flows toward L. Duff. Site C4 is located upstream of L.Duff.

The average results across all three months for the sites are presented in **Table 4-5** below. In general, these rivers have low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating acidic conditions.

pH ranged from 4.32 to 5.61 with Site C4 having the lowest average pH readings which just breaches the lower EQS boundary. Suspended sediments and DOC levels remained steady and low for the three months.

Levels of metals showed a marked decreases at sites C5 and C4 in April (aluminium, iron, manganese and zinc). On the other hand, aluminium and zinc levels where nearly five times higher than February levels at site C8 in April. In addition, the EQS for copper was below limit of detection for all sites in all months except site C8 in April where the levels breeched EQS

All sites with the exception of C5 breeched the EQS for zinc. This site had a slightly higher hardness value >10mg/l and therefore EQS for zinc is set higher than the other sites.

All other parameters which have an EQS set conform to these standards. Mean ortho-P and ammonia levels indicate High status at all sites.

Table 4-5: Average results (February- April) for paramaters measured at sites C8, C2,C5 & C4. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C8 (u/s forestry)	C2	C5	C4
Alkalinity (mg/L $CaCO_3$)	9	10	8	15
Aluminium (µg/L)	22.33	29	23	41.67
Ammonia (mg/L as N)	0.027	0.023	0.027	0.03
Calcium (mg/L)	2.2	1.033	0.733	1.2
Conductivity (at 20°C)	51.53	54.93	55.73	76.1
Copper (µg/L)	10	All samples below LOD <0.002	All samples below LOD <0.002	All samples below LOD <0.002
Dissolved Organic Carbon (mg/L)	6.767	9.533	7.4	15.033
Hardness Total (mg/L $CaCO_3$)	7.667	9	12	9
Iron (µg/L)	168	583	186.33	243.67
Magnesium (mg/L)	0.9	0.93	0.97	1.23
Manganese (µg/L)	9.67	20.33	12.33	21.33
Nickel (µg/L)	1	All samples below LOD <1	All samples below LOD <1	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51	All samples below LOD <0.51	All samples below LOD <0.51	All samples below LOD <0.51

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	C8 (u/s forestry)	C2	C5	C4
pH (pH Units)	4.8	5.3	5.3	4.5
Phosphate-Ortho (mg/L)	All samples below LOD <0.01	0.02	All samples below LOD <0.01	0.01
Phosphorus-Total (mg/L as P)	All samples below LOD <0.03	0.03	All samples below LOD <0.03	0.035
Potassium (mg/L)	0.47	0.37	0.4	0.566666667
Sodium (mg/L)	7.37	8.33	8.4	11.2
Solids-Total Suspended (mg/L)	All samples below LOD <2*	2*	All samples below LOD <2*	All samples below LOD <2*
Zinc (µg/L)	26.33	16	23	9.67

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

4.2.2. C1, C3, C7 & C10

The sites are located in the north-western section of Cappaghoosh. The rivers flow in a north-south direction through a number of lakes. Site C1 is located just upstream of the property boundary and upstream of any forestry it flows into Loughaunanny then out of this lake and into Cappaghoosh. This is a first order stream which rises only a short distance upstream. Here the river flows across open blanket bog / heath and in effect represents conditions before the river flows through afforested areas.

Site C3 is located further downstream within forestry just before the river enters L. Fadda. The river leaves this lake and then enters Loughaunemlagh, site C7 is just upstream of the inlet to the lake. The river leaves the lake and enters L. Cuskeamatinny and site 10 is located just upstream of the inlet.

The average results across all three months for the sites are presented in **Table 4-6** below. In general, these rivers have low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating acidic conditions.

pH ranged from 4.4 to 6.3 with site C10 having the lowest average pH readings which were very close to breaching the lower EQS boundary. Suspended sediments and DOC levels remained steady and low for the three months.

Metals (iron and manganese) increased in April at site C1 whereas in the other sites these decreased markedly along with aluminium and zinc. Suspended sediments and DOC levels remained steady and low for the three months.

All other parameters which have an EQS set conform to these standards with the exception of zinc at sites C7 and C10. Mean ortho-P and ammonia levels indicate High status at all sites.

Table 4-6: Average results (February- April) for paramaters measured at sites C1, C3,C7 & C10. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C1	C3	C7	C10
Alkalinity (mg/L $CaCO_3$)	8.5	9.67	8.50	10.50
Aluminium (µg/L)	31.67	22.67	16.00	27.00
Ammonia (mg/L as N)	0.027	0.030	0.020	0.035
Calcium (mg/L)	1.733	0.95	0.70	0.78
Conductivity (at 20°C)	57	58.07	65.67	76.60
Copper (µg/L)	All samples below LOD <0.002	All samples below LOD <0.002	All samples below LOD <0.002	All samples below LOD <0.002

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	C1	C3	C7	C10
Dissolved Organic Carbon (mg/L)	7.833	7.73	8.37	11.90
Hardness Total (mg/L $CaCO_3$)	12.33	14.67	8.67	9.00
Iron (µg/L)	297.67	175.33	151.00	218.00
Magnesium (mg/L)	1.07	0.97	1.03	1.20
Manganese (µg/L)	23.67	16.67	25.67	37.00
Nickel (µg/L)	All samples below LOD <1	All samples below LOD <1	All samples below LOD <1	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51	All samples below LOD <0.51	All samples below LOD <0.51	All samples below LOD <0.51
pH (pH Units)	5.7	5.1	4.9	4.6
Phosphate-Ortho (mg/L)	0.01	All samples below LOD <0.01	All samples below LOD <0.01	All samples below LOD <0.01
Phosphorus-Total (mg/L as P)	0.03	All samples below LOD <0.03	0.04	0.04
Potassium (mg/L)	0.5	0.43	0.40	0.50
Sodium (mg/L)	8.27	9.00	9.70	11.23
Solids-Total Suspended (mg/L)	All samples below LOD <2*	All samples below LOD <2*	All samples below LOD <2*	All samples below LOD <2*
Zinc (µg/L)	14.67	13.33	9.33	10.67

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

4.2.3. Sites C6, C9 & C13

The sites are located in the western section of Cappaghoosh. The rivers flow in a north-south direction through a number of lakes. Site C6 is located just upstream of the property boundary, upstream of any forestry and just upstream of L. Minnaun. This is a first order stream which rises only a short distance upstream. Here the river flows across open blanket bog / heath and in effect represents conditions before the river flows through afforested areas.

The river leaves L. Minnaun and follows the western boundary of the property until it enters L. Cuskeamatinny. Site C9 is located at the inlet to this lake. The lake turns into L. Owengarve and the Owengarve River flows out of this toward L. Curreel. Site C13 is just upstream the inlet to L. Curreel.

The average results across all three months for the sites are presented in **Table 4-7** below. In general, these rivers have low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and low pH indicating acidic conditions.

pH ranged from 4.4 to 5.9 with site C13 having the lowest average pH readings which were just in breach of the lower EQS boundary. Suspended sediments and DOC levels remained steady and low for the three months.

Metals (aluminium, iron, manganese and zinc) decreased markedly in April at C9 whereas in the same month metals increased at site C13 with this site recording the highest average levels of all metals with the exception of zinc. Of note at C13 is the average level of copper which was three times higher than the EQS. EQS for zinc was exceeded at all sites.

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All other parameters which have an EQS set conform to these standards. Mean ortho-P and ammonia levels indicate High status at all sites. Average levels of ammonia however were just within High EQS boundary.

Table 4-7: Average results (February- April) for paramaters measured at sites C6, C9 & C13. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C6	C9	C13
Alkalinity (mg/L $CaCO_3$)	13	11	9
Aluminium (µg/L)	23.67	18.33	49.00
Ammonia (mg/L as N)	0.023	0.040	0.035
Calcium (mg/L)	0.75	0.75	1.40
Conductivity (at 20°C)	62.2	70.2	78.0
Copper (µg/L)	All samples below LOD <0.002	All samples below LOD <0.002	15.000
Dissolved Organic Carbon (mg/L)	5.733	7.867	10.700
Hardness Total (mg/L $CaCO_3$)	9.00	9.33	9.33
Iron (µg/L)	157.00	114.67	295.67
Magnesium (mg/L)	1.07	1.17	1.27
Manganese (µg/L)	18.00	16.00	51.67
Nickel (µg/L)	All samples below LOD <1	1.00	1.00
Nitrate (mg/L as N)	All samples below LOD <0.51	All samples below LOD <0.51	All samples below LOD <0.51
pH (pH Units)	5.0	5.0	4.5
Phosphate-Ortho (mg/L)	All samples below LOD <0.01	0.010	All samples below LOD <0.01
Phosphorus-Total (mg/L as P)	0.030	All samples below LOD <0.03	All samples below LOD <0.03
Potassium (mg/L)	0.40	0.50	0.50
Sodium (mg/L)	9.47	10.67	11.03
Solids-Total Suspended (mg/L)	All samples below LOD <2*	All samples below LOD <2*	All samples below LOD <2*
Zinc (µg/L)	16.67	18.00	17.00

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

4.2.4. Sites C15 -C18

The results of these four sites are grouped together as they are all located within the same river system. C15 and C16 are in separate channels in the upper reaches with both rising from the same parcel of forestry. These channels both flow through a medium sized lake and then meet each other just upstream of C17. At C17 forestry borders the right bank and open bog on the left. Immediately downstream of C17 the river enters another lake and C18 is located downstream of this lake with forestry still on the right and bog on the left.

The average results across all three months for the sites are presented in **Table 4-8** below. In general, the rivers have low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and very low pH indicating acidic conditions across all sites.

pH levels were very low across all sites in all months ranging from pH 4.4 to 5.9. Site C15 and C16 had the lowest average pH readings across any of the 18 sites sampled in Cappaghoosh and were both in breach of the lower EQS boundary.

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Suspended sediments and DOC levels remained steady and low for the three months. An exception was site C15 in February were suspended solids peak at 18mg/l, although this is below the standard of an annual average ≤25mg/l it is the highest suspended sediment reading across both properties and stands out. Rainfall in February was very low with drier than average conditions and levels returned to undetectable in March and April during high rainfall months. This high reading could potentially be an anomaly or potentially disturbance of the substrate when the sample was taken as water may have been very low in this small first order stream.

Average zinc levels were elevated above the EQS for all sites except C15. Average copper levels were elevated above the EQS for sites C15 and C16. Site C16 had the highest levels of metals compared to the other sites (aluminium, copper, iron and zinc). The sampler noted the river can be dry here and sometimes the water in the drainage ditch is sampled. It is unknown however which months this occurred in.

All other parameters which have an EQS set conform to these standards. Mean ortho-P and ammonia levels indicate High status at all sites.

Table 4-8: Average results (February- April) for paramaters measured at sites C15, C16, C17 & C18. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C15	C16	C17	C18
Alkalinity (mg/L $CaCO_3$)	11.50	6.50	8.50	10.50
Aluminium (µg/L)	77.67	122.67	31.67	34.33
Ammonia (mg/L as N)	0.030	0.023	0.020	0.023
Calcium (mg/L)	1.60	1.80	0.67	0.67
Conductivity (at 20°C)	82.07	77.27	55.57	56.63
Copper (µg/L)	9.00	16.00	Below LOD <2	Below LOD <2
Dissolved Organic Carbon (mg/L)	22.03	15.27	7.07	6.97
Hardness Total (mg/L $CaCO_3$)	12.50	9.67	8.67	8.33
Iron (µg/L)	379.67	507.67	208.00	246.33
Magnesium (mg/L)	1.17	1.20	0.93	0.97
Manganese (µg/L)	1.33	12.67	19.00	25.00
Nickel (µg/L)	1.00	1.00	Below LOD <1	Below LOD <1
Nitrate (mg/L as N)	Below LOD <0.51	Below LOD <0.51	Below LOD <0.51	Below LOD <0.51
pH (pH Units)	4.3	4.4	5.1	5.1
Phosphate-Ortho (mg/L)	0.01	0.01	Below LOD <0.01	Below LOD <0.01
Phosphorus-Total (mg/L as P)	0.04	0.03	Below LOD <0.03	Below LOD <0.03
Potassium (mg/L)	0.23	0.23	0.23	0.37
Sodium (mg/L)	12.40	10.47	8.57	8.53
Solids-Total Suspended (mg/L)	18.00	Below LOD <2*	Below LOD <2*	Below LOD <2*
Zinc (µg/L)	32.00	33.33**	14.00	9.67

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

** Samples exceed EQS in surface water regulations and also standard of 30mg/l (hardness <10mg/l) in the salmonid regulations

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4.2.5. C11 & C12

Sites C11 and C12 are located in the centre of the Cappaghoosh property. The river here rises within the forestry and flows in an east-west direction toward L. Owengarve. Site C12 is located in the upper reaches of the channel near the source and site 11 is located just upstream of the inlet to the lough.

The average results across all three months for the sites are presented in **Table 4-9** below. In general, the river has low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and very low pH indicating acidic conditions across both sites.

pH levels were very low across both sites in all months, it ranged from pH 4.2 to 4.6. Both site C11 and C12 were in breach of the lower EQS boundary for pH. Suspended sediments and DOC levels remained steady and low for the three months.

Nutrients were low across both sites with average ammonia and ortho-P falling within the EQS for High Status.

Table 4-9: Average results (February- April) for paramaters measured at sites C11 & C12. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C11	C12
Alkalinity (mg/L $CaCO_3$)	Below LOD <2	12.3
Aluminium (µg/L)	68.33	82.33
Ammonia (mg/L as N)	0.033	0.027
Calcium (mg/L)	1.6	1.63
Conductivity (at 20°C)	85.7	93.6
Copper (µg/L)	13	11
Dissolved Organic Carbon (mg/L)	16.67	19.73
Hardness Total (mg/L $CaCO_3$)	9.33	11
Iron (µg/L)	344	592.7
Magnesium (mg/L)	1.27	1.53
Manganese (µg/L)	16.33	13
Nickel (µg/L)	1	1
Nitrate (mg/L as N)	Below LOD <0.51	Below LOD <0.51
pH (pH Units)	4.4	4.5
Phosphate-Ortho (mg/L)	0.01	0.01
Phosphorus-Total (mg/L as P)	0.03	0.03
Potassium (mg/L)	0.33	0.43
Sodium (mg/L)	11.7	13.97
Solids-Total Suspended (mg/L)	All samples below LOD <2*	5
Zinc (µg/L)	22.67	20

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

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4.2.6. C14

This site is located on a small stream in the southern section of the Cappaghoosh property. From satellite imagery the parcel of forestry the river rises from was felled sometime between 2015-2019.

It does not appear to have been replanted but some trees have regenerated. The river then flows into L. Curreel.

The average results across all three months for the sites are presented in **Table 4-10** below. In general, the river has low alkalinity (i.e., low buffering capacity to neutralise acids), very soft water (few dissolved minerals), low nutrients and very low pH indicating acidic conditions across both sites.

pH levels were very low in all months ranging from pH 4.2 to 4.8 with the average just in breach of the lower EQS boundary. Suspended sediments and DOC levels remained steady and low for the three months.

Metals (aluminium, copper, iron, manganese and zinc) all saw a large decrease in April. However, the average levels of zinc were still in breach of the EQS. Nutrients were low across both sites with average ammonia and ortho-P falling within the EQS for High Status.

Table 4-10: Average results (February- April) for paramaters measured at sites C14. Green text indicates initial results are within EQS and red text indicates initial results exceed EQS.

	C14
Alkalinity (mg/L $CaCO_3$)	12.00
Aluminium (µg/L)	45.33
Ammonia (mg/L as N)	0.033
Calcium (mg/L)	1.60
Conductivity (at 20°C)	69.57
Copper (µg/L)	All samples below LOD <2
Dissolved Organic Carbon (mg/L)	16
Hardness Total (mg/L $CaCO_3$)	9.33
Iron (µg/L)	195
Magnesium (mg/L)	1.07
Manganese (µg/L)	4.67
Nickel (µg/L)	All samples below LOD <1
Nitrate (mg/L as N)	All samples below LOD <0.51
pH (pH Units)	4.5
Phosphate-Ortho (mg/L)	0.02
Phosphorus-Total (mg/L as P)	0.06
Potassium (mg/L)	0.27
Sodium (mg/L)	9.47
Solids-Total Suspended (mg/L)	4.00*
Zinc (µg/L)	13.00

*Samples do not exceed 25mg/l which is standard set in the salmonid regulations.

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5. SUMMARY

The initial water chemistry results assessed (January/February- April) show that the rivers in both Derryclare and Cappaghoosh are characterised by low alkalinity, low water hardness, low nutrients and low pH.

In terms of pH the results would indicate that these rivers exhibited acidic conditions over prolonged periods with an average of pH 5.2 across all sites in Derryclare and pH 4.8 across all sites in Cappaghoosh. Whether the rivers naturally exhibit this very low pH or if this is due to forestry/peat

drainage is unknown as there is no water chemistry prior to afforestation. Given the quartzite and schist geology the rivers would be considered naturally acidic with very limited buffering capacity associated with this geology. This makes the rivers sensitive to further acidification and both properties are located in areas designated as acid sensitive areas (DAFM, 2015). For these reasons these rivers would lack the capacity to cope with additional acidity and it is likely that land use activities have exacerbated the pH levels resulting in more extreme and prolonged low pH levels. Initial results indicate that average pH exceeded the lower EQS[2] boundary (samples should be > pH 4.5) at a number of sites in Cappaghoosh (C4, C11, C12, C13, C14, C15, C16).

Low pH can impact macroinvertebrate communities and is generally associated with low species diversity (Hildrew *et al.,* 1984; Hildrew & Giller 1994). Low to moderate diversity was observed during the 2023 biological sampling. The low pH values would also limit the salmonid potential within these rivers with an annual average pH <6 considered unsuitable as per the Salmonid Regulations. Sudden decreases of pH can result in gill and skin irritation in salmon and trout. Acid irritates the gills resulting in excessive mucus production and can cause reddened areas on the abdomen.

Acidity levels also influence the solubility of metals in the geology, soils and stream water. One particular metal, aluminium, becomes soluble below pH <5.5 forming monomeric aluminium which is toxic to fish and insects. No EQS has yet been set for monomeric aluminium as it is difficult to predict monomeric levels from total aluminium. Copper and zinc are two metals which also have a toxic effect upon aquatic biota and do have EQSs. All Derryclare sites exceeded the EQS for zinc. In Cappaghoosh 13 out of 18 sites were also above the EQS for zinc. The EQS for copper was also exceeded in 6 out of 18 sites in Cappaghoosh. A large increase in metals occurred in March/April at most sites. February was unseasonably dry and this was followed by a very wet March and April. This wet period may have flushed mobilised metals from the soils into the rivers.

Nutrients were low satisfying the High status EQS for both ammonia and ortho-P in all sites except for one. This exception was site P4 in Derryclare with ammonia indicating Good not High. This waterbody has been modelled at High WFD status and therefore would be expected to achieve High for supporting nutrient conditions.

In terms of the biological samples the results in Derryclare were of interest. The waterbody here has been modelled at High WFD status and again would be expected to achieve High biological quality (Q4-5 or Q5) if sampled. One river did achieve this High biological quality in the upper reaches but then declined to Good further downstream. One river showed a marked departure from High biological quality with a Q3-4 assigned indicating Moderate quality. The results would indicate that this waterbody in Derryclare would struggle to achieve the modelled High WFD status.

In Cappaghoosh, the Q-values varied from Good to Poor. Site CB-E was the most degraded with a Q3 assigned indicating Poor biological quality. This is also an EPA monitoring point and long-term data shows that the site has failed to achieve Q4 (Good) since 2003. Excessive algal growth was observed on the substrate here which could indicate nutrient enrichment issues however the water chemistry results taken close to the biological site indicate low nutrients during winter/early spring (June water chemistry is pending). It may be that the low flows and open sunny habitat created ideal conditions for algal growth combined with limited grazing invertebrates to keep algal growth in check. Oxygen

[2] Please note that majority of EQS set in the Surface Water Regulations are based on an annual average over a 12-month period. As only 3-4 months data has been collected the comparison with the EQS set in the serves as a guide only.

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levels were satisfactory on the day of survey. It was unclear on the day what may be the cause of the poor quality but the very low macroinvertebrate diversity may indicate some low-level toxic impact or a hydrological pressure as a result of the low flows.

Finally, it should be noted that during the biological sampling water levels were very low with some rivers almost drying out and this may have impacted the Q-value score. It would be interesting to see if the Q-values improve in higher flows. While these rivers may naturally have low summer flows the impact of drainage and climate change resulting in more frequent and prolonged extreme flows are likely compounding the situation. These rivers flow across open habitats with little to no shading and the water temperatures recorded on the day were quite high. All these factors, including the low pH place additional pressures upon the rivers within Derryclare and Cappaghoosh which may help to explain why some are not achieving High or even Good biological quality.

The results of the water chemistry and biological sampling paint a complicated picture across both properties but it is clear there are pressures acting upon these water bodies including but not limited to; flow, pH and excessive metals.

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6. REFERENCES

Igoe, F., O'Grady, M.F., Tierney, D. and Fitzmaurice, P. (2003) 'Arctic Char *Salvelinus alpinus* (L.) in Ireland: A Millennium Review of its Distribution and Status with Conservation Recommendations', *Biology and Environment: Proceedings of the Royal Irish Academy*, 103B(1), pp9–22.

DAFM (2015) *Forestry Standards Manual.* Forestry Service, Department of Agriculture Food and the Marine. Johnstown Castle Estate, Wexford.

EA (2003) 'River Habitat Survey in Britain and Ireland: Field Survey Guidance Manual'. Version 2003. Environment Agency, UK.

EPA (2021) *Third Cycle Draft Lower Shannon Catchment Report (HA31)*. Catchment Science and Management Unit, Environmental Protection Agency. Version 1. https://catchments.ie/wp-content/files/catchmentassessments/31%20Galway%20Bay%20North%20Catchment%20Summary%20WFD%20Cycle%203.pdf

Hildrew, A.G., Townsend, C.R. and Francis, J. (1984) 'Community Structure in some Southern English Streams: The Influence of Species Interactions', *Freshwater Biology*, 14(3), pp.297-310.

Hildrew, A. and Giller, P. (1994) 'Patchiness, species interactions and disturbance in the stream benthos', *Aquatic ecology – scale pattern and processes.* BES symposium, Cork, 1992 (eds P.S. Giller, A.G. Hildrew& D.G. Raffaelli), pp. 21-62. Blackwell Science, Oxford

McGarrigle, M.L., Bowman, J. J., Clabby, K. J., Lucey, J., Cunningham, P., MacCárthaigh, M., Keegan, M., Cantrell, B., Lehane, M., Clenaghan C. and Toner, P. F. (2002) *Water Quality in Ireland 1998 – 2000*. Environmental Protection Agency, Johnstown Castle Ireland.

NIEA (2014). *River Hydromorphology Assessment Technique (RHAT) Training Manual*. Northern Ireland Environment Agency, Northern Ireland. Version 2.

Toner, P., Bowman, J, Clabby, K., Lucey, J., McGarrigle M., Concannon, C., Clenaghan C., Cunnunghan, P., Delaney, S., O'Boyle, S., MacCárthaigh, M., Craig, M., and Quinn, R. (2005). *Water Quality in Ireland 2001-2003*. Environmental Protection Agency, Johnstown Castle Ireland.

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Appendix A
Summary of biological field survey results

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Table A- 1: Summary of general habitat characteristics for surveys completed in Derryclare 2023.

	Site DB-1	Site DB-2	Site DB-3	Site DB-4	Site DB-5	Site DB-6
Co-ordinates	53.48118, -9.76519	53.48367, -9.76132	53.50622, -9.74725	53.50484, -9.75973	53.50996, -9.74706	53.51832, -9.76209
DO% mg/l	30, 2.63	100.7 , 8.67	85.9, 7.93	99.3, 9.26	141, 13	95, 8.93
Temp °C	23	19.5	19	18	18	18.3
Conductivity uS/cm	95	62	59	55	113	49
pH	6	5.57	4.76	6.25	5.4	5.6
Bank height (m)	0.1	0.5	1	2	1	0.3
Bank wetted width (m)	0.3	2.5	3	1	1	1.5
Average depth (m)	>1	0.1	0.1	0.1	>1	0.07
Water colour	High	Moderate	Low	Moderate	High	Moderate
Bank erosion	None	None	Moderate	Moderate	Moderate	Moderate
Shading	None	Light	Light	Light	Moderate-heavy	None
Substrate (%)	Peat/silt:100	Bedrock Boulder: 35 Cobble: 25 Coarse gravel: 20 Fine gravel: 10 Sand: 8 Silt: 2	Bedrock Boulder: 0 Cobble:25 Coarse gravel: 35 Fine gravel: 20 Sand:15 Silt: 5	Bedrock 15 Boulder: 35 Cobble: 25 Coarse gravel: 15 Fine gravel: 5 Sand: 5 Silt: 0	Peat/silt:100	Bedrock: 0 Boulder: 5 Cobble: 45 Coarse gravel: 28 Fine gravel: 15 Sand: 5 Silt: 2
Surface siltation	Heavy	None	None	None	Heavy	Low
Plume of silt	Heavy	None	None	None	Heavy	None
Substrate comment	Estimation due to coloured water	-	-	-	-	-
River habitat (%)	Stagnant:100	Riffle: 0 Glide: 90 Pool: 10	Riffle: 40 Glide: 60 Pool: 10	Riffle: 40 Glide: 50 Pool: 10	Stagnant: 100	Riffle: 60 Glide: 30 Pool: 10
Flow velocity	Stagnant	Slow	Slow	Moderate	Stagnant	Slow
Landuse	Forestry (mature, clearfelling) mod. blanket bog	Woodland-broadleaved	Forestry-coniferous	Forestry-coniferous	Forestry-coniferous	Blanket bog / Heathland
Filamentous green algae (%)	None	None	10	20	40	25
Note	-Brown hawker -Large red damselfly -Willow warbler -Siskin	-Large red damselfly -Cuckoo	-Red deer	-	-	-Meadow pipit -Skylark -Beautiful demoiselle -Cuckoo

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Table A- 2: Summary of general habitat characteristics for surveys completed in Cappaghoosh 2023.

	Site CB-A	Site CB-B	Site CB-C	Site CB-D	Site CB-E
Co-ordinates	53.46323, -9.71129	53.46084, -9.6966	53.41824, -9.69301	53.41996, -9.67442	53.40698, -9.65463
DO (%) (mg/l) **Temp (°C)** **Conductivity (µS/cm)** **pH**	116.4, 10.1 21 89 8.15	78.6, 6.85 21 67 6.4	-	-	96.9, 8.62 20 58 6.48
Bank height (m)	0.5	0.2	1	-	0.7
Bank wetted width (m)	7	5	12	-	2.5
Average depth (m)	0.3	0.2	>0.6	0	0.3
Water colour	Low	Low	High	-	Low
Bank erosion	Light	Moderate	Light	None	Light
Shading	Light	Light	None	None	Light
Substrate (%)	Bedrock: 0 Boulder: 10 Cobble: 35 Coarse gravel: 25 Fine gravel: 20 Sand: 5 Silt: 5	Bedrock: 10 Boulder: 15 Cobble: 30 Coarse gravel: 25 Fine gravel: 13 Sand: 2 Silt: 5	Bedrock: 0 Boulder: 0 Cobble: 0 Coarse gravel: 0 Fine gravel: 15 Sand: 5 Silt/Peat: 80	-	Bedrock: 0 Boulder: 20 Cobble: 25 Coarse gravel: 30 Fine gravel: 15 Sand: 5 Silt: 5
Surface siltation	Low	Low	Heavy	-	Low
Plume of silt	Moderate	Moderate	Heavy	-	Low- moderate
Substrate comment	-	-	Soft and sinking	-	-
River habitat (%)	Riffle: 30 Glide: 50 Pool: 20	Riffle: 5 Glide: 85 Pool: 10	Riffle: 0 Glide: 100 Pool: 0	-	Riffle: 10 Glide: 70 Pool: 20
Flow velocity	Slow- moderate	Slow	Stagnant- slow	-	Moderate
Landuse	Heath Woodland- broadleaved	Heath Lake upstream	Heath	Heath Peat bog (drained)	Heath Peat bog
Filamentous green algae (%)	30	20	-	-	80
Note	-Skylark	-Meadow pipit -Bullfinch -Willow warbler -Skylark	Sea eagle on island in L. Curreel	-	Keeled skimmer dragonfly

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Table A- 3: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site DB-2.

Site DB-2 Taxon	Group	Pollution tolerance	Abundance 2023
Protonemura sp.	A	Sensitive	Few
Amphinemura sp.	A	Sensitive	Single
Leptophlebiidae	B	Less sensitive	Few
Polycentropodidae	C	Tolerant	Common
Rhyacophila dorsalis	C	Tolerant	Few
Hydropsychidae	C	Tolerant	Few
Dytiscidae	C	Tolerant	Few
Limnius volckmari	C	Tolerant	Few
Hydraenidae	C	Tolerant	Few
Simuliidae	C	Tolerant	Numerous
Chironomidae	C	Tolerant	Numerous
Lumbricidae	C	Tolerant	Few
Hydracarina sp.	C	Tolerant	Few
Taxon Richness			**12**
Q-value			**Q3-4**

Table A- 4: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site DB-3.

Site DB-3 Taxon	Group	Pollution tolerance	Abundance 2023
Electrogena sp.	A	Sensitive	Common
Chloroperlidae	A	Sensitive	Few
Protonemura sp.	A	Sensitive	Few
Leuctra sp.	B	Less sensitive	Common
Polycentropodidae	C	Tolerant	Few
Hydropsychidae	C	Tolerant	Few
Simuliidae	C	Tolerant	Numerous
Hydracarina sp.	C	Tolerant	Common
Esolus/Oulimnius	C	Tolerant	Few
Tipula sp.	C	Tolerant	Few
Dipertan larva	C	Tolerant	Few
Tubificids	E	Most tolerant	Few
Taxon Richness			**12**
Q-value			**Q4**

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Table A- 5: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site DB-4.

Site DB-4 Taxon	Group	Pollution tolerance	Abundance 2023
Electrogena sp.	A	Sensitive	Numerous
Amphinemura sp.	A	Sensitive	Common
Leuctra sp.	B	Less sensitive	Few
Polycentropodidae	C	Tolerant	Few
Hydropsychidae	C	Tolerant	Few
Rhyacophila dorsalis	C	Tolerant	Few
Simuliidae	C	Tolerant	Common
Chironomidae	C	Tolerant	Few
Limnius volckmari	C	Tolerant	Few
Taxon Richness			**9**
Q-value			**Q4-5**

Table A- 6: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site DB-6.

Site DB-6 Taxon	Group	Pollution tolerance	Abundance 2023
Chloroperlidae	A	Sensitive	Common
Isoperla grammatica	A	Sensitive	Common
Electrogena sp.	A	Sensitive	Few
Leuctra sp.	B	Less sensitive	Common
Rhyacophila dorsalis	C	Tolerant	Few
Limnius volckmari	C	Tolerant	Few
Esolus/Oulimnius	C	Tolerant	Few
Chironomidae	C	Tolerant	Few
Simuliidae	C	Tolerant	Numerous
Hydracarina sp.	C	Tolerant	Few
Lumbricidae	D	Very tolerant	Few
Taxon Richness			**11**
Q-value			**Q4**

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Table A- 7: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site CB-A.

Site CB-A Taxon	Group	Pollution tolerance	Abundance 2023
Heptagenia sp.	A	Sensitive	Common
Isoperla grammatica	A	Sensitive	Few
Glossosomatidae	B	Less sensitive	Few
Odontoceridae	B	Less sensitive	Few
Lepidostomatidae	B	Less sensitive	Few
Baetis rhodani/atlanticus	C	Tolerant	Common
Esolus/Oulimnius	C	Tolerant	Few
Hydropsychidae	C	Tolerant	Common
Philopotamidae	C	Tolerant	Common
Rhyacophila dorsalis	C	Tolerant	Few
Hydracarina sp.	C	Tolerant	Few
Chironomidae	C	Tolerant	Numerous
Gammarus sp.	C	Tolerant	Few
Sphaerium/Pisidium sp.	D	Very tolerant	Few
Tubificidae	E	Most tolerant	Few
Taxon Richness			**15**
Q-value			**Q4**

Table A- 8: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site CB-B.

Site CB-B Taxon	Group	Pollution tolerance	Abundance 2023
Heptagenia sp.	A	Sensitive	Few
Isoperla grammatica	A	Sensitive	Few
Leuctra sp.	B	Less sensitive	Few
Sericostoma personatum	B	Less sensitive	Few
Baetis rhodani /atlanticus	C	Tolerant	Common
Serratella ignita	C	Tolerant	Common
Simuliidae	C	Tolerant	Numerous
Hydropsychidae	C	Tolerant	Few
Polycentropodidae	C	Tolerant	Few
Philopotamidae	C	Tolerant	Few
Chironomidae	C	Tolerant	Few
Hydracarina sp.	C	Tolerant	Few
Esolus/Oulimnius	C	Tolerant	Few
Sphaerium/Pisidium sp.	D	Very tolerant	Numerous
Glossiphonia complanata	D	Very tolerant	Few
Taxon Richness			**15**
Q-value			**Q3-4**

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Table A- 9: Summary of macroinvertebrate taxa observed and Q-value results in surveys completed to date for site CB-E.

Site CB-E Taxon	Group	Pollution tolerance	Abundance 2023
Lepidostomatidae	B	Less sensitive	Few
Polycentropodidae	C	Tolerant	Few
Hydropsychidae	C	Tolerant	Common
Philopotamidae	C	Tolerant	Common
Chironomidae	C	Tolerant	Numerous
Simuliidae	C	Tolerant	Common
Hydracarina sp.	C	Tolerant	Few
Lumbriculidae	C	Tolerant	Few
Taxon Richness			**7**
Q-value			**Q3**

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Appendix B
Graphs of water chemistry results

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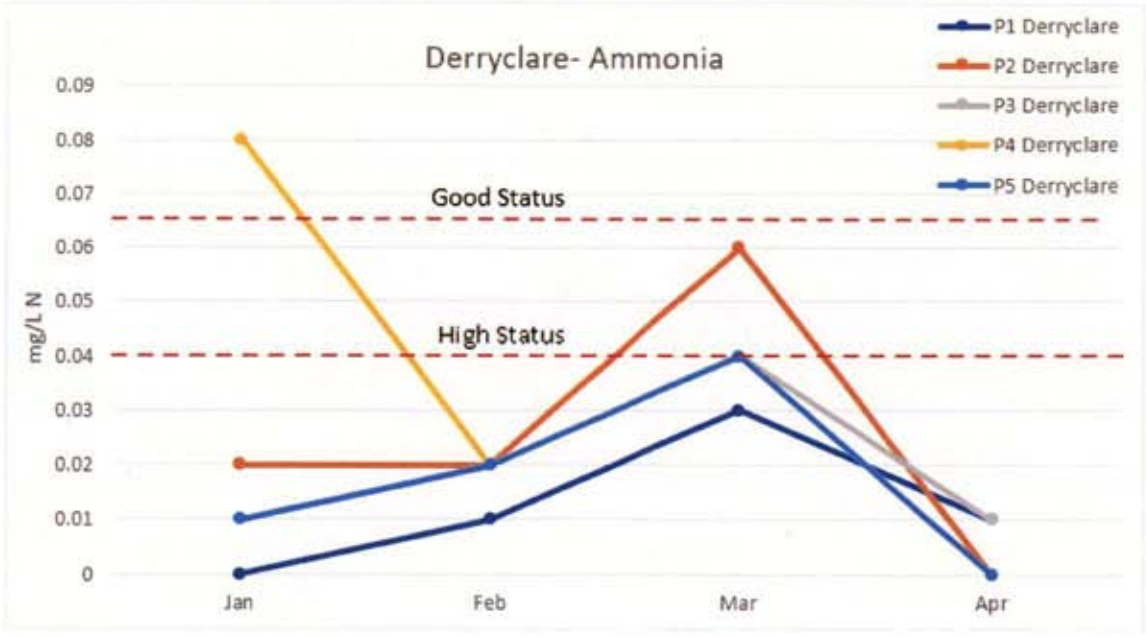

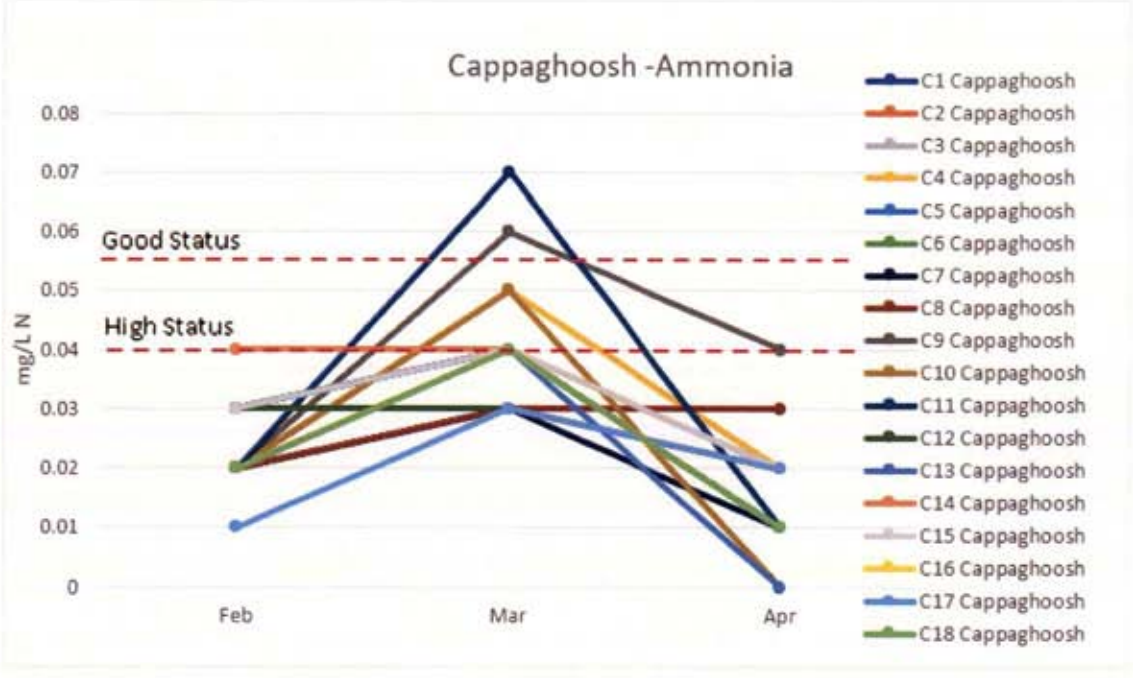

Table B-1: Results for ammonia for the months sampled for both Derryclare and Cappaghoosh properties. The red dashed line indicates the EQS boundary for ammonia as per the surface water regulations. High status ≤0.040 (mean) / ≤0.090 (95%ile). Good status ≤0.065 (mean) / ≤0.140 (95%ile

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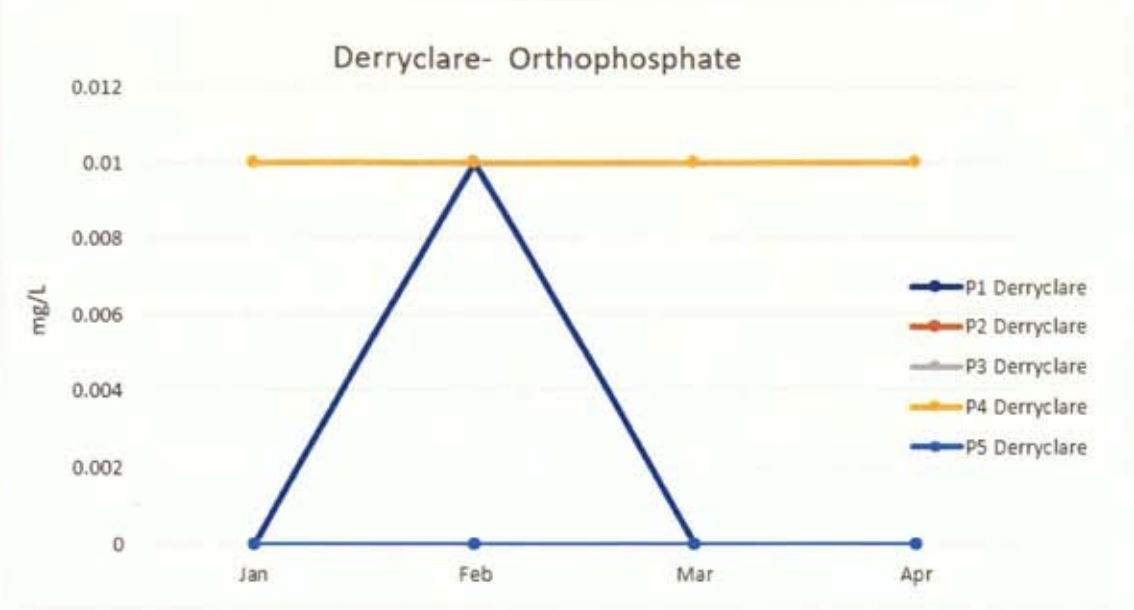

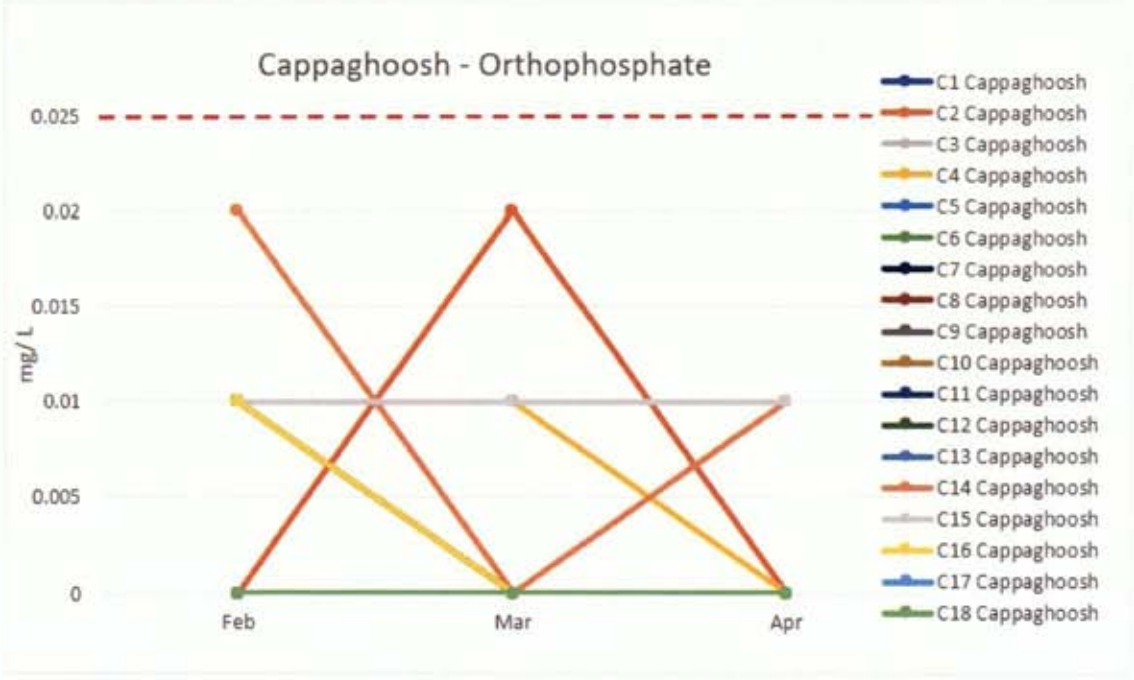

Table B-2: Results for orthophosphate for the months sampled for both Derryclare and Cappaghoosh properties. The red line indicates EQS boundary for phosphate (MRP) as per the Surface Water Regulations. High status ≤0.025 (mean) / ≤0.045 (95%ile). Good status ≤0.035 (mean) / ≤0.075 (95%ile). Orthophosphate is taken as a proxy for MRP.

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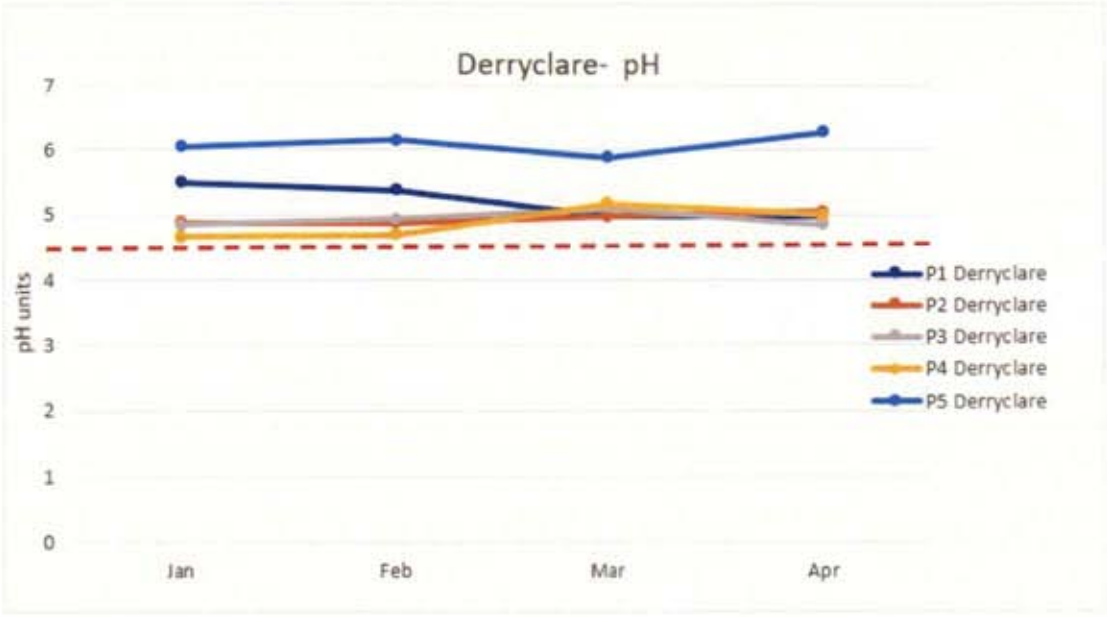

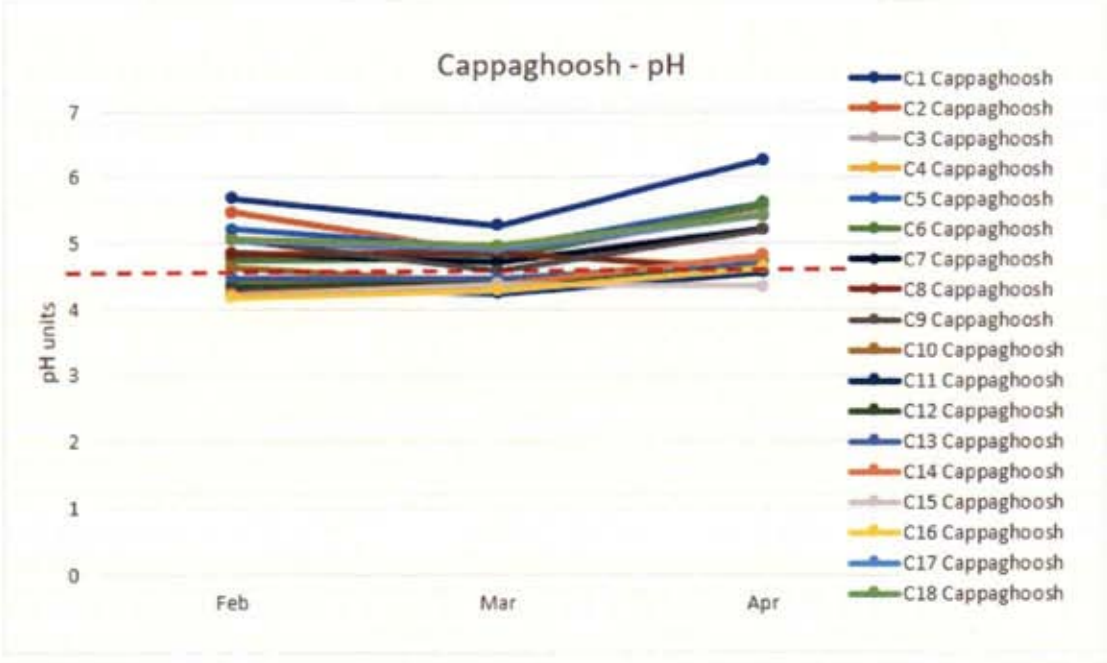

Table B-3: Results for pH for the months sampled for both Derryclare and Cappaghoosh properties. The red dashed line indicates the lower EQS boundary for pH at 4.5 as per the Surface Water Regulations.

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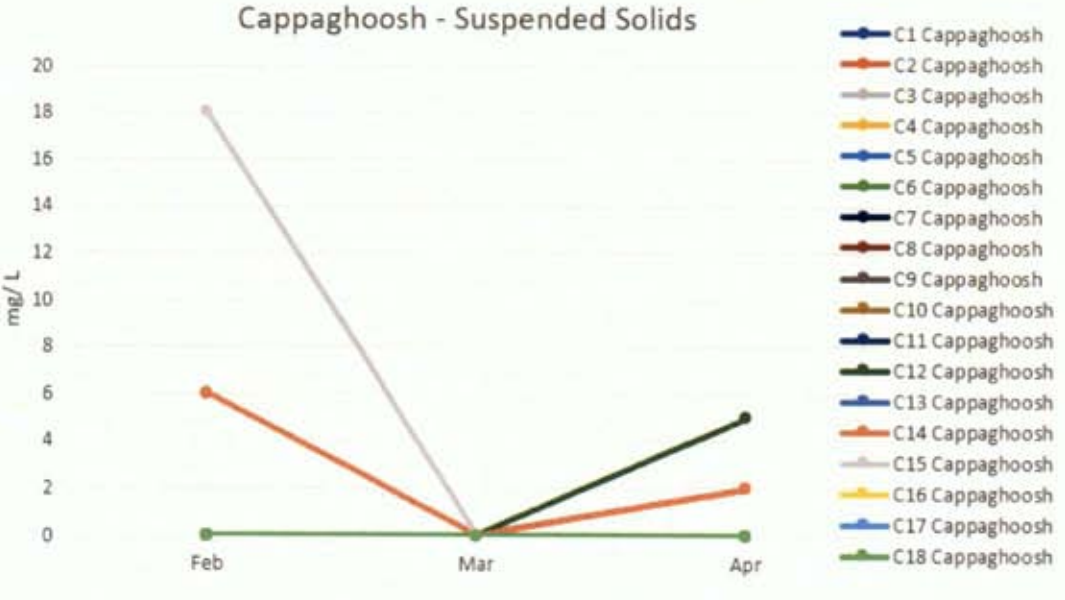

Table B-4: Results for suspended solids for the months sampled for both Derryclare and Cappaghoosh properties. The standard set for suspended solids within the Salmonid Regulations is an annual average of 25mg/L.

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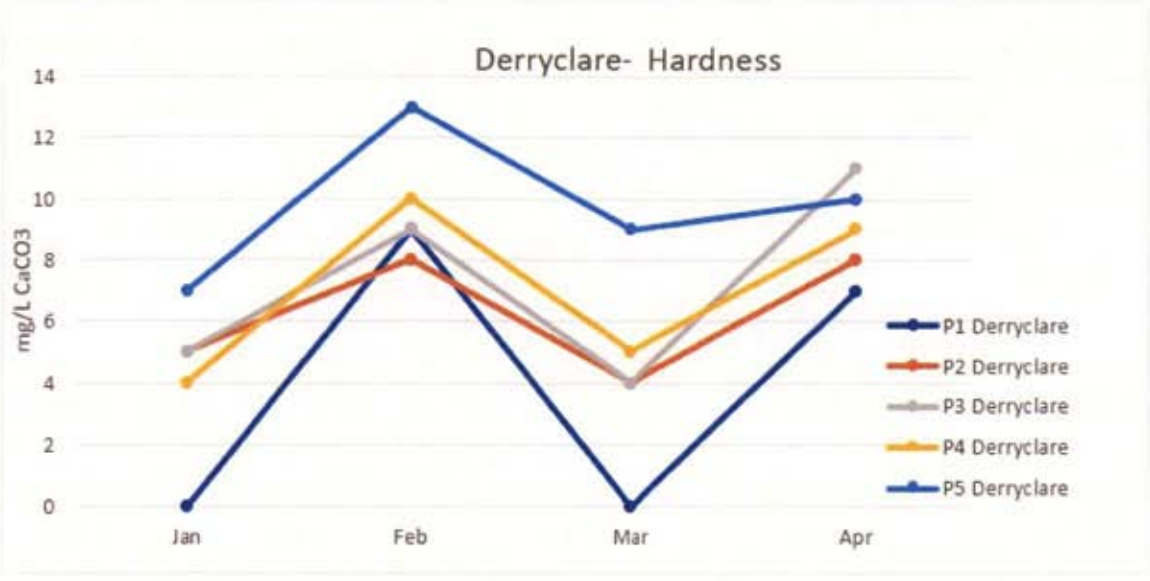

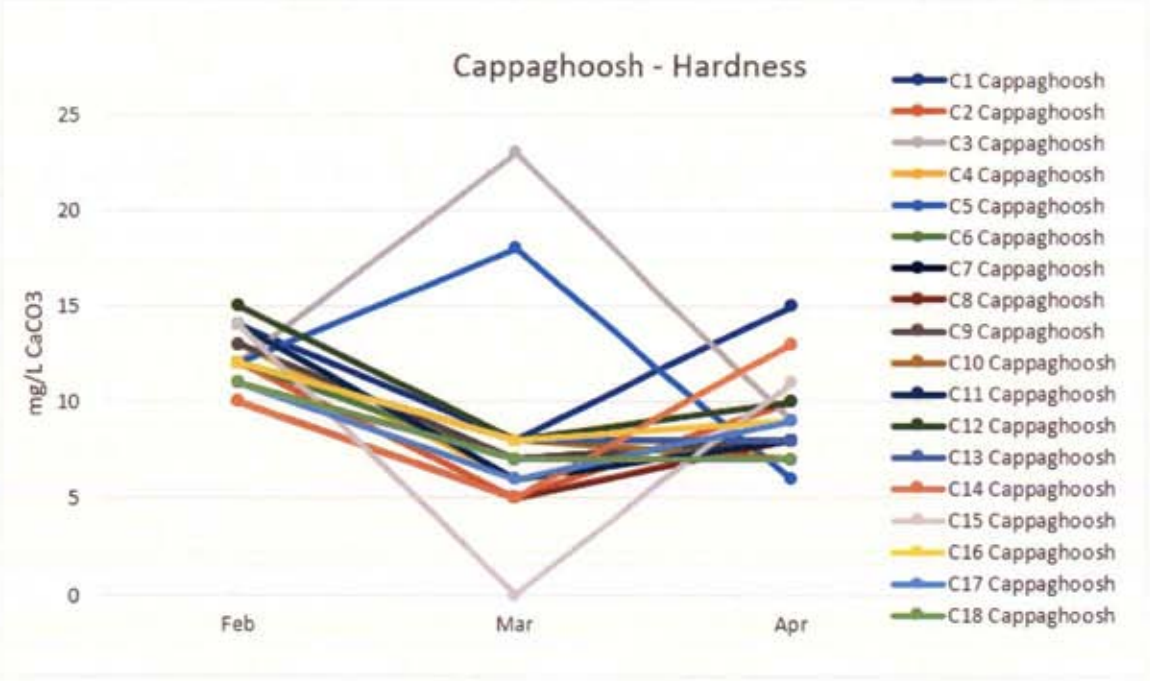

Table B-5: Results for water hardness for the months sampled for both Derryclare and Cappaghoosh properties. No EQS standards are set within the Surface Water Regulations.

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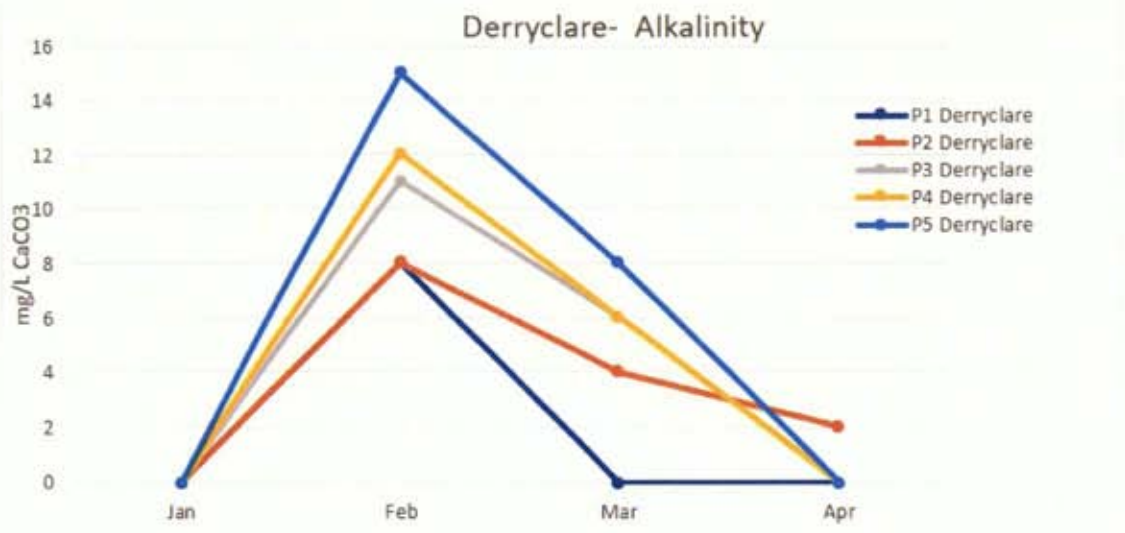

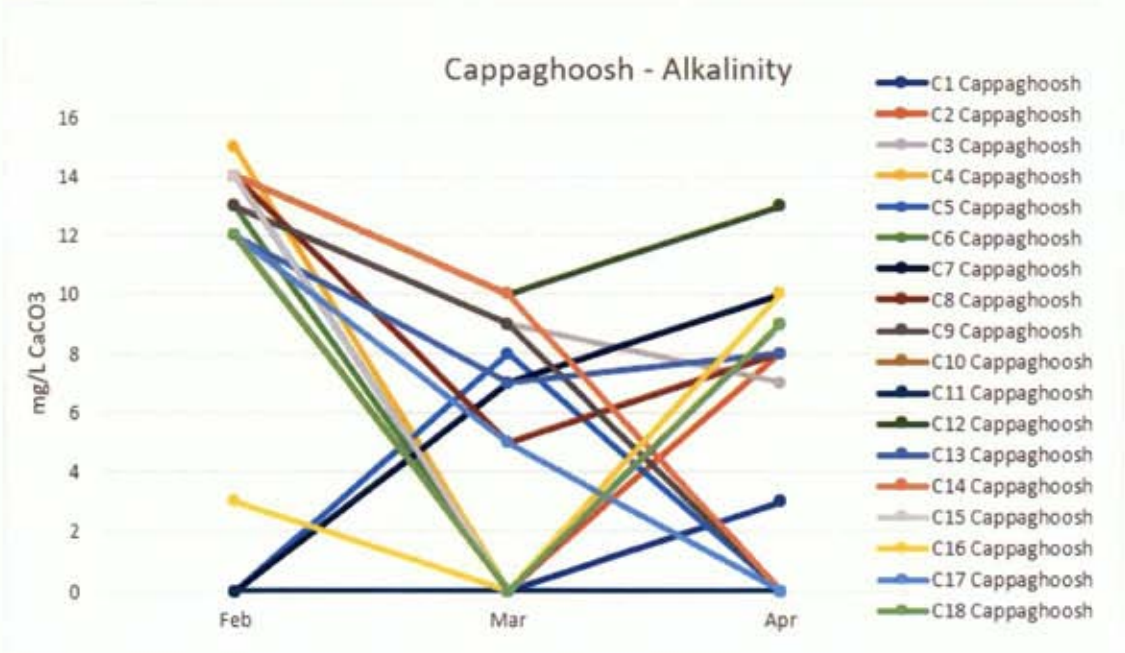

Table B-6: Results for alkalinity for the months sampled for both Derryclare and Cappaghoosh properties. No EQS standards are set within the Surface Water Regulations.

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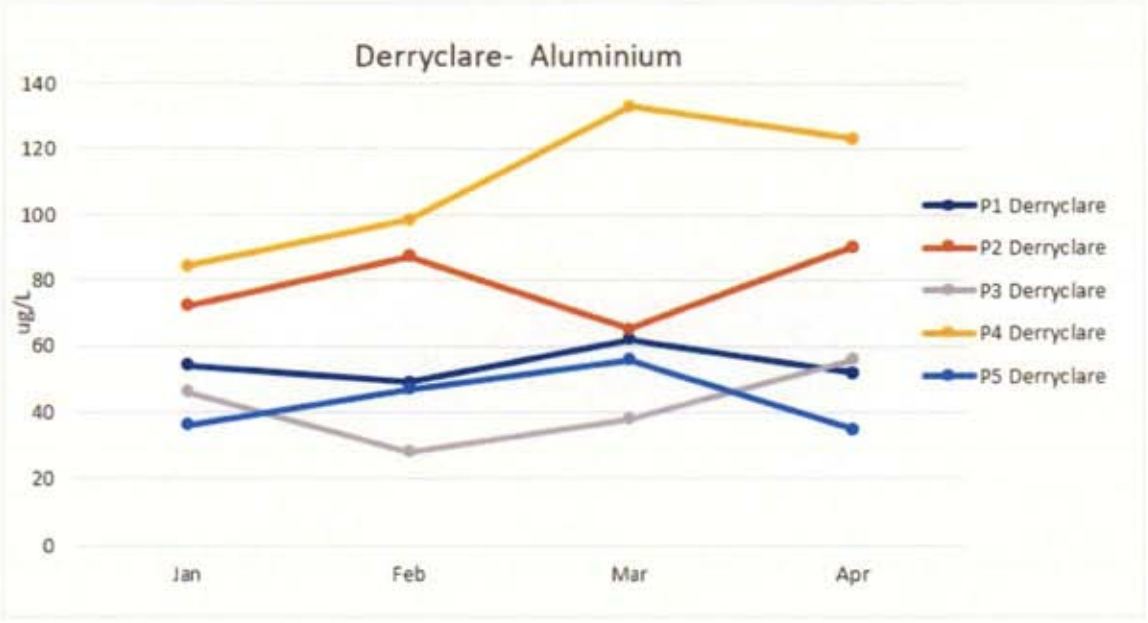

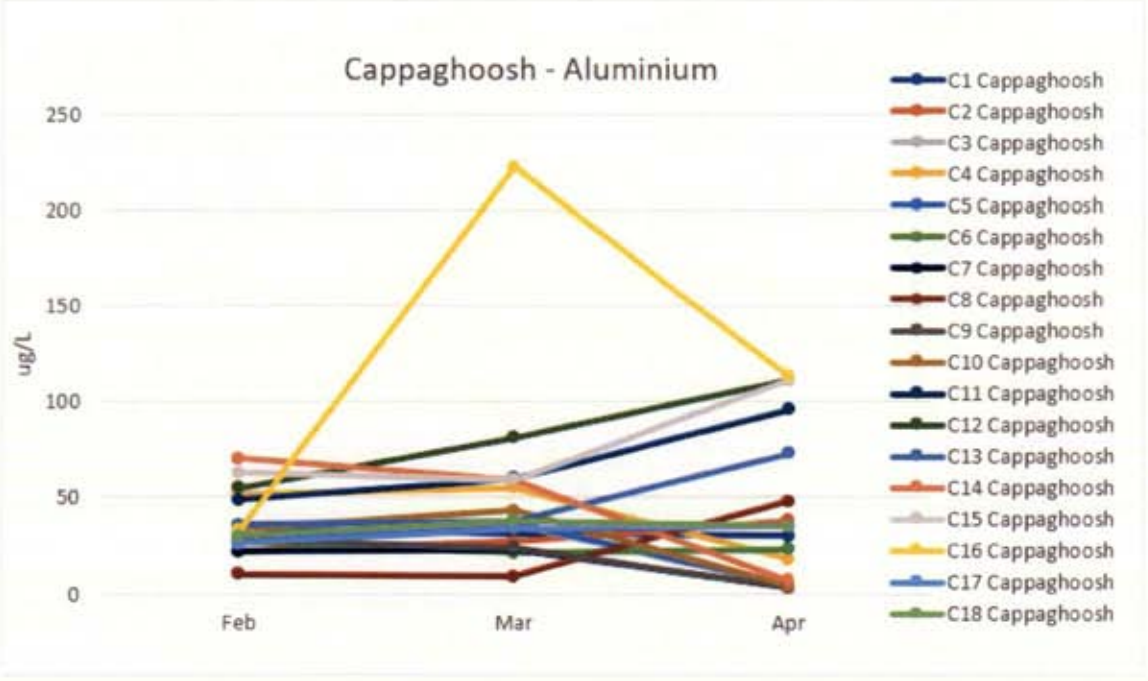

Table B-7: Results for aluminium for the months sampled for both Derryclare and Cappaghoosh properties. No EQS standards are set within the Surface Water Regulations.

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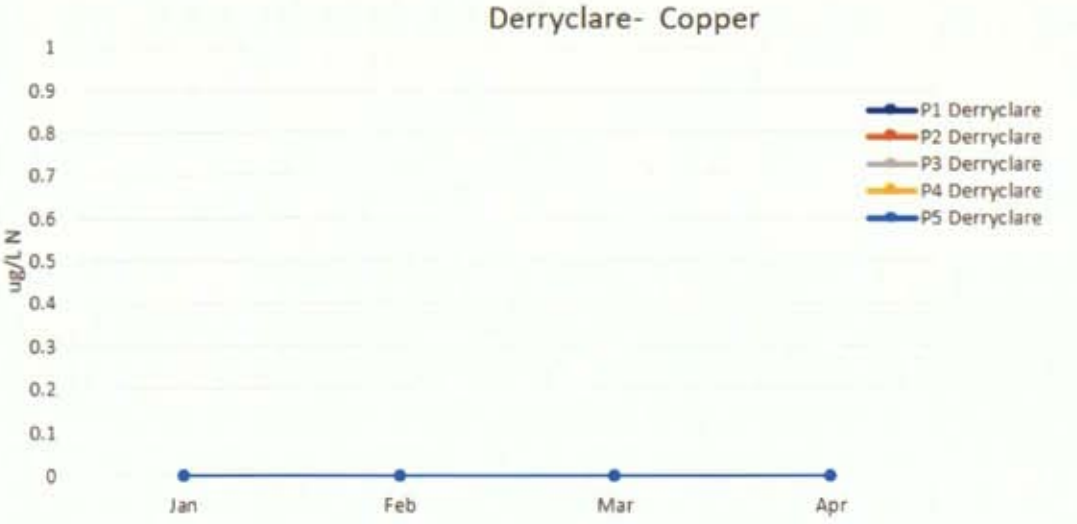

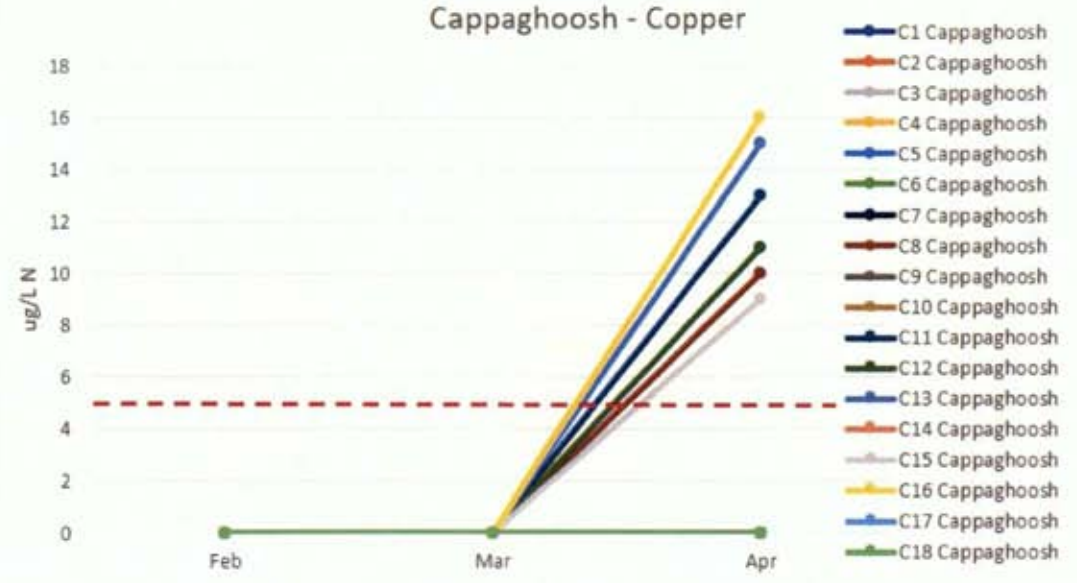

Table B-8: Results for copper for the months sampled for both Derryclare and Cappaghoosh properties. The red dashed line indicated the EQS boundary for copper as per the Surface Water Regulations. This is 5µg/L for water hardness ≤100mg/L $CaCO^3$. All sites fit into this category for average water hardness.

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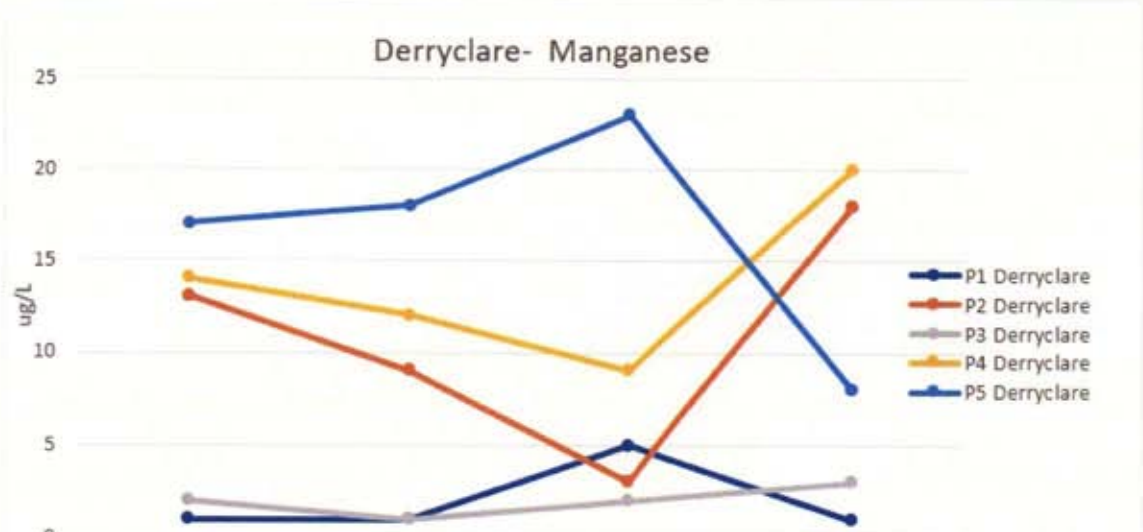

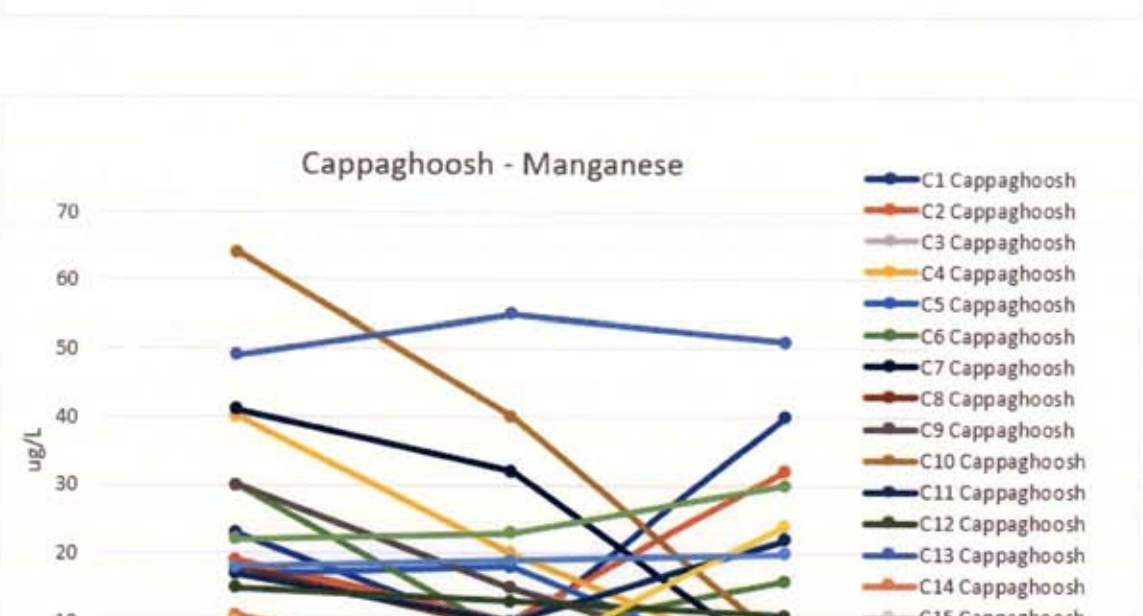

Table B-9: Results for manganese for the months sampled for both Derryclare and Cappaghoosh properties. No EQS standards are set within the Surface Water Regulations.

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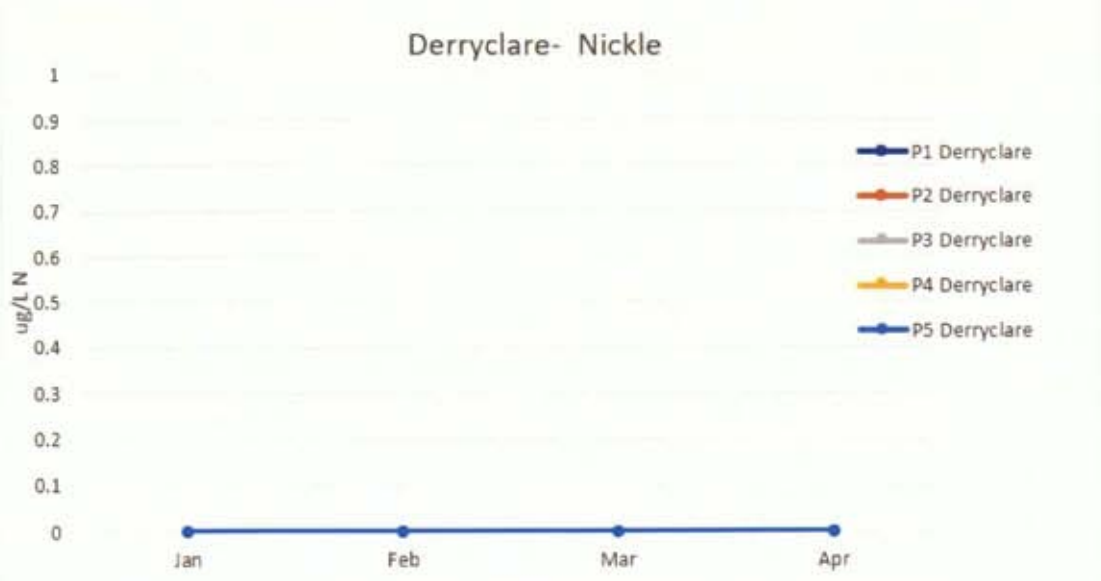

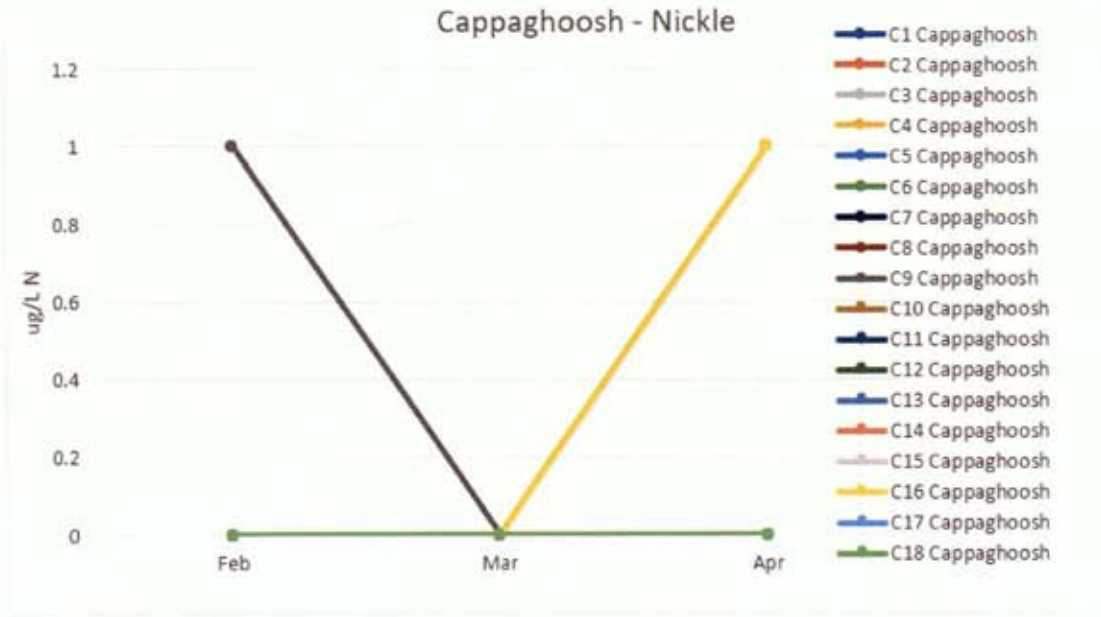

Table B-10: Results for nickel for the months sampled for both Derryclare and Cappaghoosh properties. The EQS boundary for Nickle is 20 µg/L as per the Surface Water Regulations.

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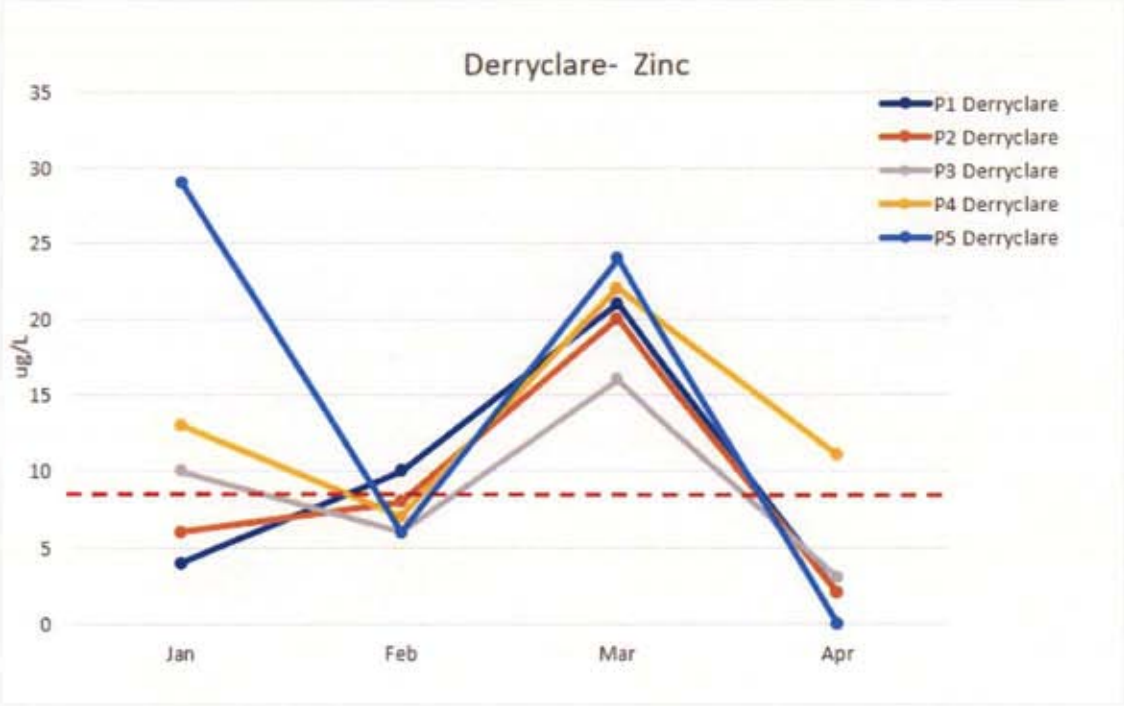

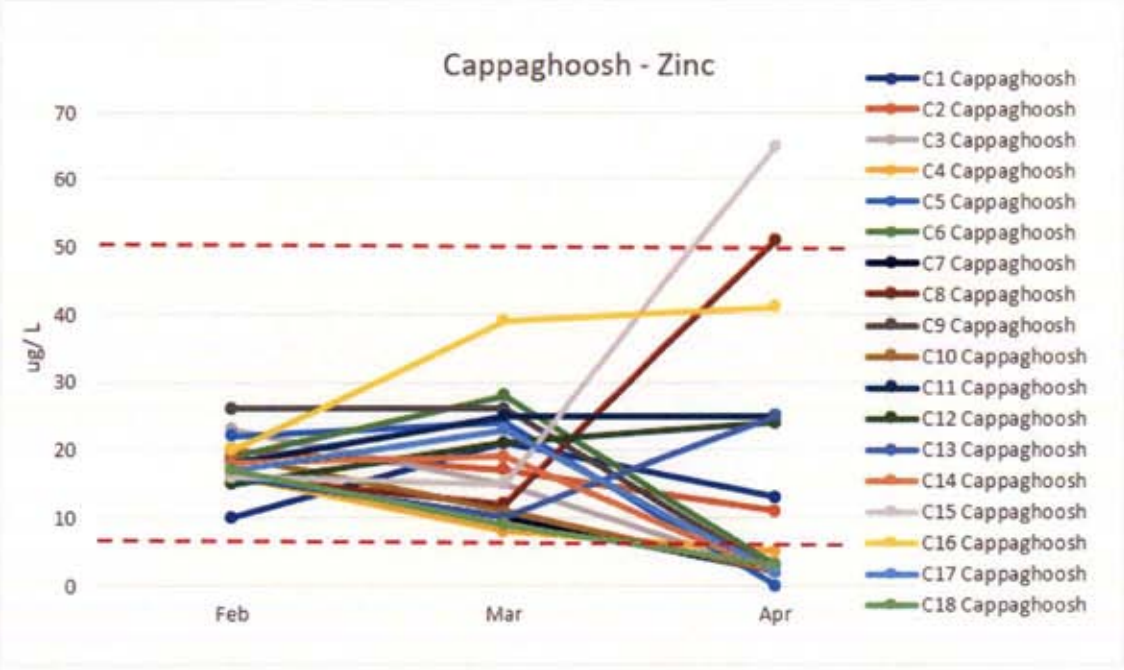

Table B-11: Results for zinc for the months sampled for both Derryclare and Cappaghoosh properties. Red line indicates the EQS boundary for zinc as per the Surface Water Regulations. This is 8ug/L for water hardness with annual average ≤10mg/L $CaCO^3$. 50µg/L for water hardness with annual average >10 to ≤100mg/L $CaCO^3$. Most sites fall into the first category with low average water hardness. Site C1, C3, C5 and C15 fall into the latter category.

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APPENDIX 4

DERRYCLARE MANAGEMENT AND MAINTENANCE PLAN INCLUDING FIRE PLAN

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Derryclare management and maintenance plans

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1.0 Introduction

This report details the Derryclare management and maintenance plans in one document. These plans deal with ongoing management and general maintenance issues that will be managed over the entirety of the project implementation stage. This report covers 5 key areas, namely,

- Invasive species management plan.
- Grazing management plan (including deer management).
- Fire plan.
- General maintenance plan (including public usage).

Invasive species management plan

Invasive species can cover a range of plant species, however, in Derryclare, following a detailed ecological assessment, the main pressure from invasive species was identified to come from rhododendron ponticum and conifer reseeding with mainly lodgepole pine. There are many papers on rhododendron ponticum control (Higgins, (2008) Cross, (1973) Rotherham, (1983). Edwards, (2006)) and it is well understood. Their control is essential and often problematic and success removal requires continual vigilance and many costly interventions. Regeneration of lodgepole pine seedings is also a known issue with peatland restoration in Ireland and it must also be managed. The plan to deal with this described below.

Grazing management plan (including deer management)

Grazing pressures from mainly sheep, livestock and deer can lead to dominance by Molinia caerulea and Eriophorum vaginatum (Shaw & Wheeler, 1994) with a decline in Sphagnum species (Lindsay, 2010). The main grazing pressure in Derryclare is from sheep, deer and occasionally cattle. The plan to deal with this described below.

Fire plan

Fires tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. For infrequent fires there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires, (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return when burning has produced a bare peat surface (Evans & Warburton, 2007). Derryclare is an area historically at risk from wildfires and as a result, this pressure must be managed. The plan to deal with this described below.

General maintenance plan (including public usage)

General maintenance is a catch all that refers to addressing issues as they arise and they can include a wide variety of tasks such as road maintenance, silt trap and dam inspections and repairs, dumping, vandalism, erection, and repair of signage, dealing with the public and local requests arising from consultations. For Derryclare the most important general maintenance is expected to be silt trap and dam inspections and

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maintenance, keeping the main access road in good repair and issues with the public such as recreational usage, dumping and vandalism. The plan to deal with this described below.

2.0 Invasive species management plan

2.1 Summary of the invasive species management plan

Following an ecological survey, the main invasive species threat in Derryclare was identified as Rhododendron ponticum and conifer reseeding, with no other invasives observed. The control of rhododendron is a priority as it is seen as one of the largest threats to the success of the restoration works. The baseline data has shown that rhododendron is present at a low-level on a property wide basis and it has the potential to become a large high-level infestation, especially once ground disturbance occurs during restoration. Therefore, annual property wide interventions are planned for Derryclare. The treatment will adopt the methodology researched by the NPWS in the adjoining forest property in Kylemore (described below). The treatment has proven itself to be suited to the conditions in Connemara and it is expected to be a good fit for Forest to bog projects. The entire property will be treated annually, so that by the time initial tree removal begins, most of the rhododendron stems will be dead and can be windrowed along with the forest brash. In addition, all newly restored areas will also be included in the annual treatment, so that all new saplings will be treated or removed. As the restoration programme is spread out over 8 years, the expectation is that all restored areas will be free from rhododendron, and this will be used as one measure to monitor the success of the treatment programme. This annual approach, although intensive, is deemed necessary to manage the rhododendron threat in Derryclare. Intermittent surveys will be carried out to monitor progress, including the visual surveys and sampling surveys described below. New survey methods such as drone surveys or remote sensing can also be adopted, if proved successful. These surveys occur when the rhododendron is flowering and can be a cost-effective way to map a site. Conifer reseeding will be manged in two ways, namely by a) creating unfavourable conditions for seeding germination by removing where possible the raised dry plough ridge using surface smoothing, and 2) where seedlings regenerate, these will be removed when they are young enough to be pulled up out of the ground or cut with a garden lopper. In terms of carrying out the site works, it is planned to link in with Forum Connemara, who in co-operation with the NPWS have set up a dedicated local work gang to treat rhododendron in Connemara. This gang has already been employed to carry out the detailed baseline mapping described below. Treatment of rhododendron will be one of the first actions to be scheduled and it will remain a priority throughout the project.

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2.2 Introduction

The main invasive species threat in Derryclare is from Rhododendron ponticum. There are many papers on rhododendron control (Higgins, (2008) Cross, (1973) Rotherham, (1983). Edwards, (2006)) and it is well understood. Their control is essential and often problematic and successful removal requires continual vigilance and many costly interventions. Regeneration of lodgepole pine seedings is also a known issue with peatland restoration in Ireland. This is typically associated with tree removal of mature crops with heavy cone production and sites that were ploughed. The cones of lodgepole pine and their seed can remain viable for many years, and regeneration on restored sites is most often found where the original plough ribbon is left intact, offering slightly drier conditions that favour seedling regeneration. According to Campbell et al., (2019) conifer regeneration can be dealt with by surface smoothing methods, but otherwise must be removed manually. In Scotland, it was observed that carrying out the restoration work immediately post felling and raising the water table as soon as possible, is an effective way to limit conifer and invasive species regeneration by creating unfavourable conditions for seeding germination. Where seedlings regenerate, the optimum time to remove them is when they are young enough to be pulled up out of the ground or cut with a garden lopper. Allowing the seedlings to grow any older will require a chainsaw intervention.

The plan to manage Rhododendron ponticum and conifer seedling regeneration in Derryclare involves the following.

1. Establish the baseline level of infestation of rhododendron ponticum.
2. Schedule annual property wide interventions.
3. Monitor progress.
4. Use local community groups for field work.

2.3 Establish the baseline infestation level.

To assess the invasive species in Derryclare and the level of infestation, two baseline surveys were conducted, namely:

a) The ecologist walk-over survey.
b) Detailed sampling survey using a 10m transect method.

2.3.1 The ecologist walk-over survey.

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During the ecological assessment of the site, the ecologist conducted a walk-over survey to identify the invasive species present and describe the level of infestation, using the standard DAFOR scale. The most widely used method for assessing the level of infestation of invasive species in a forestry setting uses the DAFOR method and descriptions. This method uses the existing forestry sub compartment boundaries and provides a generic textual description of the level of infestation based on walk over observations. The descriptions are D for Dominant, A for Abundant, F for Frequent, O for Occasional and R for Rare. This data is then used to produce a heat map, which gives a general estimation of the level of infestation over a wide area. This approach provides sufficient data to inform an operational plan to manage invasives. The results are presented in Map 1 below.

The DAFOR scale

PRESENT used where Rhododendron is considered likely to be present but not sufficiently walked to rate following DAFOR as below:

D for Dominant: In practice you will rarely, if ever use this. To score **D,** a species would have to be the most common plant by far, in well over three quarters of the square. It is possible that in a square that is entirely conifer plantation, that Sitka spruce Picea sitchensis might score **D;** or in a square that is almost all occupied by highly improved grassland, perennial rye-grass Lolium perenne might sometimes score **D,** but even these two scenarios are unlikely most of the time. If you are not sure if something should score **D** or **A,** give it **A.**

A for Abundant: Only use **A** if the plant was really very common in many parts of the square. For most species this would mean that there were thousands of individual plants present. In most squares, few species will score as highly as **A** and in quite a few squares there will be no species that score that highly. If you are not sure if something should score **A** or **F,** give it **F.**

F for Frequent: Use **F** if you found the plant in several places in the square and there was usually more than just **A** few individuals in each of these places. You could also use **F** if the plant was only present in one part of the square but was very common in that part, with many individuals and covered **A** substantial area (e.g. between one eight and one quarter of the area of the whole square). If you are not sure if something should score **F** or **O,** give it **O.**

O for Occasional: Use **O** for species that occur in several places in the square, but whose populations are usually not very big. You would also use **O** for species that are very common in one bit of habitat within the square that occupied just a small area (e.g less than one eight of the area of the whole square). You will use **O** for many species in most squares. If you are not sure if something should score **O** or **R,** give it **R.**

R for Rare: Use **R** for any species that occur as a small number of individuals in the square. This small number of individuals may be located in one place in the square, or scattered over several different locations within the square. In many squares **R** is likely to be the score that most species get. If you are not sure if something should score **O** or **R,** give it **R.**

For those of you who are used to using the DAFOR scale, please stick to the basic 5 scores only and avoid entries like **O/F** (occasional to frequent) and particularly please avoid using the prefix '**L**' as in **LF** (locally frequent).

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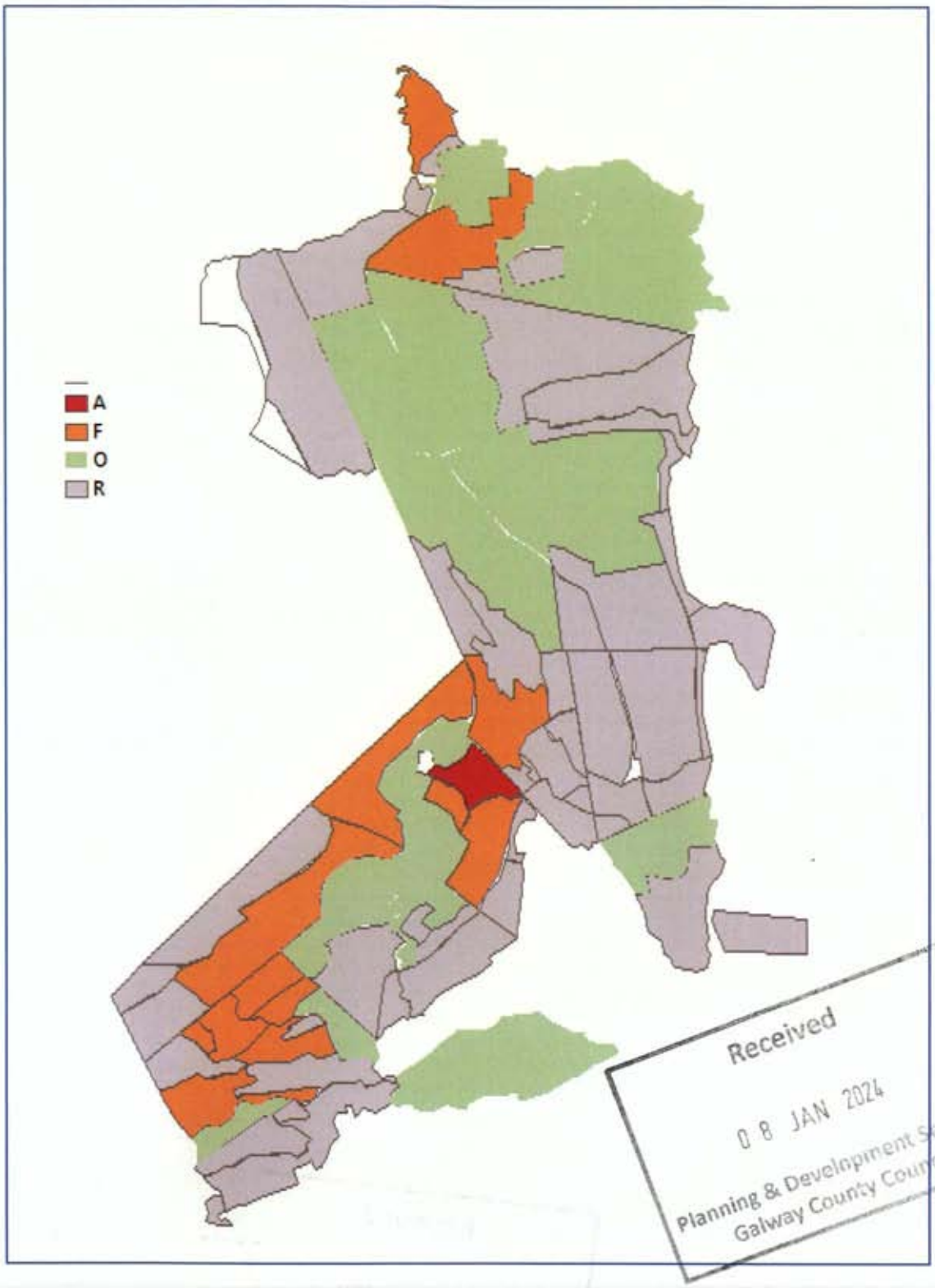

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Map 1: Rhododendron infestation levels by sub-compartment from the Ecologist site walk-over survey using the *DAFOR* scale.

2.3.2 Detailed sampling survey using a 10m transect method.

One limitation of the DAFOR method is that it does not provide the exact locations of the individual rhododendron plants and to provide this, a more detailed survey was deemed necessary. The intensive methodology used by the NPWS (under the Kerry LIFE project) was initially considered, and it was decided that this approach was too intensive and impractical to adopt in Derryclare. A sampling approach was decided as the best fit for Derryclare, as it addressed the limitation of the DAFOR method, and it was less intensive and more practical than the method used in the Kerry LIFE project. This sampling approach collected the essential detail required and ensured the process could be replicated in future years to monitor progress. This sampling method is called the '10m transect method'. Please refer to Appendix A for observations made when using this sampling method.

The 10m transect method was adopted for Derryclare, to establish a baseline for future monitoring. The 10m transect method is a sampling method that involves a work gang walking a transect of 10m grids throughout the whole property and taking observations at each intersection point on the grid. In Derryclare, 3 people walked through the forest in a line 10m apart from each other. At every 10m intervals the line stopped, and an assessment was made on the level of infestation within a 5m radius from their location. All data was recorded, and geo referenced using GPS Trimble devises, using the ArcGIS Field Maps application. If no rhododendron was present, no data was collected. If rhododendron was present, a point was recorded with a comment to describe the circumference of the bush(es) sizes (see Table 1). The walk over survey also encountered sub-compartments that were fully infested with rhododendron, and these were noted during the field work and added in as polygons on the baseline map. This field data was then mapped in ArcMap 10.6.1 to form the baseline level of rhododendron infestation in Derryclare (see Map 2).

Table 1: Comments used in the ArcGIS Field maps app to describe the infestation.

Description	Explanation	Comment
Rhodo1	Bush size circumference 1m or less	Mostly seedlings (pre flowering)
Rhodo2	Bush size circumference 2m or less	Small bush(es)
Rhodo3	Bush size circumference 3m or less	Larger bush(es)
Rhodo4	Bush size circumference over 3m	Mature clumps

This sampling method has the following main advantages:

- It allows for a relatively quick and accurate field assessment to be made.
- the exact locations within +/- 5m are provided.
- it provides details on the different stages of maturity of the infestation.
- It can provide the exact locations and a more general heat map.
- It is practical and cost effective (3 weeks work for a gang of 3 people to cover 500 ha).
- The data can be used as the basis for am operational work plan.

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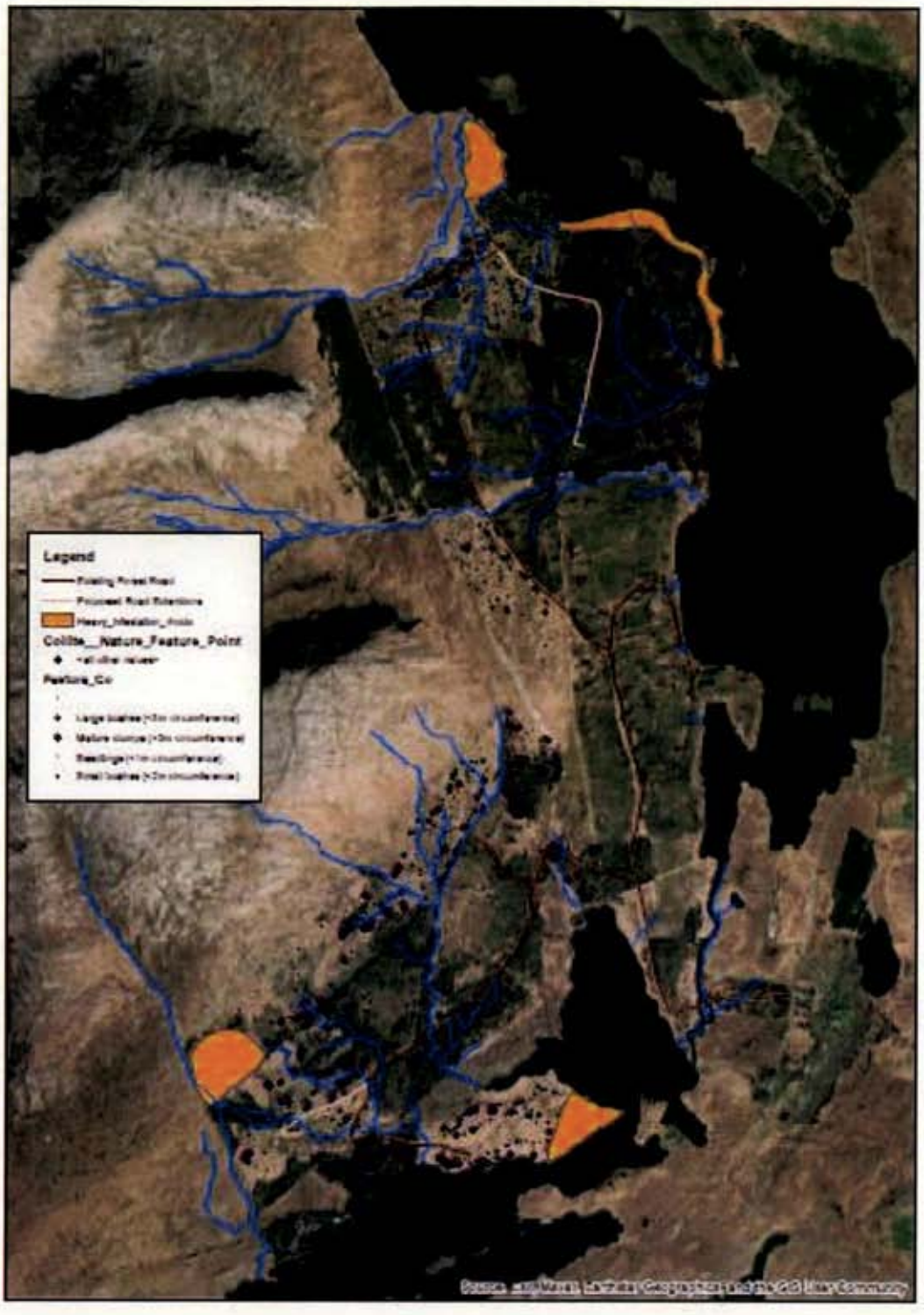

Map 2: Rhododendron infestation levels by sub-compartment from the 10m transect method sampling survey.

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Observations on mapping rhododendron using the 10m transect method.

Manually mapping invasives is not easy and it is expensive. Knowing the exact locations of individual plants using point features on a map is useful when the infestation is low, but when the infestation level is high, using a polygon feature on a map is more practical. The use of remote sensing and drones should be explored as a reasonable alternative. The heat map approach using the DAFOR method produces good results but cannot provide granular detail. The bespoke 10m sampling transect method described above produces very accurate maps and establishes a detailed baseline, but it is labour intensive. This method took 3 people 10 days to complete, and it covered an area of 350, equating to covering approximately 35 ha per day. While 90% of the area was assessable, certain areas were not assessable for two main reasons. Firstly, in some areas the levels of infestation were too high to physically allow access. In these areas, the perimeter was mapped, and a polygon created to identify these areas as polygons, as opposed a point features. Secondly, in other areas the area was inaccessible due to dense forestry vegetation (such as thicket stage crops or blown areas). In these areas, the perimeter was mapped, and a polygon created to identify that these areas were not part of the survey. The 10m sampling transect method is a very costly and demanding physically. The purpose for which the data will be subsequently used should be ascertained before deciding on using this method. Ultimately, any survey will be used to inform the operational plan to manage the invasives. In the case of Derryclare, the operational plan is to have an annual management intervention across the entire site for 7 to 10 years, as a means of dealing with invasives. In this instance, it is questionable why a detailed survey is needed, other than to provide a detailed baseline. In addition, subsequent site inoculation post ground disturbance from the felling and restoration activities will not be captured in the baseline and these will require supplementary surveys.

Observations on recent advances on mapping rhododendron.

Some initial trials were conducted using LIDAR, RGB and multispectral imagery and different platforms (aircraft and drones) to detect and map the extent of rhododendron cover. Dense canopy cover can prevent detection, and in some instances the differentiation of rhododendron from other young vegetation (particularly Sitka spruce regeneration) is less distinct resulting in false positives. These techniques particularly in areas with forest cover and mixed vegetation are still proving to be challenging and further work is needed to refine the process.

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2.4 Schedule annual property wide interventions.

The baseline data collection has shown the level of rhododendron ponticum infestation to be widespread through the property, with a mixture of plant sizes and ages. As restoration works proceed and ground disturbance increases, the latent potential for rhododendron infestation becomes even more significant. Therefore, an annual property wide intervention is needed every year, and this can be very effective as the restoration plan is staggered over several years. The methodology used will be the same one adopted by a recent NPWS study done in the adjoining forest in Kylemore. This approach works well in Connemara and is suited to a restoration programme that allows treated rhododendron plants to be treated and remain standing for a few years, before been removed. The methodology involves using a chainsaw to nick the stems of mature plants followed immediately with a spot spray of a dilute chemical. Allowing the plant to remain standing, allows the chemical to translocate through the whole plant, resulting is a higher kill rate. Owing to the multiple stems associated with rhododendron, some stems are likely to be missed, so a second, or even third pass is required each year to ensure the plant is fully killed. It is expected that repeating this every year will ensure that when it comes to felling the forest, the understory rhododendron will be dead, and it can be driven over and/or windrowed. This method also 'spot sprays' all the emerging seedlings, especially the ones in flower. Once the forest is felled and the restoration completed, either spot spraying, or preferably, hand removal of emerging seedlings can be conducted, to deal with any residual rhododendron. The aim is to ensure all restored areas are fully free from rhododendron and monitoring these areas will provide a quick visual guide the progress of the rhododendron treatment programme.

It is also noted that the source of seed for rhododendron infestation is off-site on private property. Treating the rhododendron on private lands is outside the scope of this project. However, this situation will be monitored and if an opportunity arises, co-operation will be offered to assist with rhododendron removal on these private lands. Consequently, within Derryclare property, rhododendron will need to be continuously managed.

Management of conifer reseeding will occur alongside the management plan for rhododendron. In this case each restored site will be monitored for seedling regeneration and the regeneration removed as part of the annual property wide rhododendron work. Managing it this way will ensure that the issue is addressed each year when the reseeded plants are easily managed.

An overview of the planned treatment schedule for managing rhododendron and conifer reseeding is detailed in Table 2 below.

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Table 2: The planned schedule for managing rhododendron in the Derryclare bog restoration programme.

Year	Bog restoration schedule	Rhododendron treatment
0	Secure planning permission and felling licences.	• Property wide treatment of all mature rhododendron plants and seedlings in flower.
1	Year 1 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Monitor emerging seedlings from recently restored areas.
2	Year 2 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower • Pull/threat emerging seedlings from recently felled areas. • Monitor emerging seedlings from recently restored areas.
3	Year 3 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from year 1 & 2 felled areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline.
4 to 7	Year 4 to 7 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas. • Monitor emerging seedlings from recently restored areas.
8	Year 8 felling and restoration works.	• Property wide treatment of all mature rhododendron plants and seedlings in flower. • Pull/threat emerging seedlings from all restored areas. • Monitor emerging seedlings from recently restored areas. • Conduct property wide 10m transect rhododendron survey to monitor progress against baseline.

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3.0 Grazing management plan (including deer management)

3.1 Summary

The grazing pressure in Derryclare comes from livestock (mostly sheep) and deer. The maintenance plan initially involves the construction of an external sheep fence to ensure that the entire property is fenced off. All livestock will be removed before the fence is completed. An internal deer fence will be erected to fence off the area where pioneer native woodland will be established. The site will be monitored for trespass and appropriate action taken where required, up to and including impounding. Regular checks will be made to the fence-lines to ensure they remain intact, and any breaches or faults will be repaired as a matter of urgency. Coillte have a process for impounding livestock and this process will be followed if impounding is required. Deer culling will not be used in the grazing maintenance plan as Coillte do not own the shooting rights on site. Any deer culling will only occur in agreement with the relevant stakeholders and within the law. To date, there are no immediate plans to carry out any deer culls.

Table 3: The grazing management plan by year during the restoration works.

Years	Restoration plan	Grazing plan
0 (2023)	Secure planning permission and felling licences.	• Complete external sheep fence on external boundary. • Exclude livestock from all site. • Monitor all site for trespass.
1 (2024)	Bog restoration site.	• Check sheep fence line. • Monitor all site for trespass.
2 (2025)	Pioneer native woodland sites.	• Erect deer fence stage 1. • Check sheep fence line. • Monitor all site for trespass.
3 (2026)	Pioneer native woodland sites.	• Erect deer fence stage 2. • Check sheep fence line. • Monitor all site for trespass.
4 to 8	Bog restoration sites.	• Check deer fence line. • Check sheep fence line. • Monitor all site for trespass.

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4.0 General maintenance plan (including public usage)

4.1 Summary of the plan

General maintenance is a catch all that refers to addressing outstanding issues, other than invasive species, deer and livestock grazing and fire, which are all detailed separately. General maintenance on this plan includes a wide variety of tasks such as road maintenance, silt trap and dam inspections and repairs, public usage, dumping, vandalism, erection, and repair of signage, dealing with the public and local requests arising from consultations. For Derryclare the most important general maintenance is expected to be silt trap and dam inspections and maintenance, keeping the main access road in good repair and dealing with issues with the general public such as dumping and vandalism.

General maintenance typically falls under the following headings, public usage/recreation, forest roads, operational maintenance, and anti-social activity. On terms of public usage/recreation, Coillte have an open forest policy which allows permissive access on foot to individual walkers. Across the Coillte estate an estimated 18 million visits to Coillte forests occur every year. This policy will remain in place for Derryclare. Currently, access is obtained by parking at the main entrance and entering the site on foot. This will not change. Public usage will be welcomed and facilitated with better car parking facilities at the main entrance and better signage. The forest roads are essential for site access for both operations and the general public. The forest roads will be maintained during operations. Operational maintenance during the restoration works refers to maintaining the restoration works and ensuring they remain effective. This includes silt traps, constructed dams, leaky dams, silt curtains and sonde telemetry. Other maintenance is associated with anti-social activity, such as dumping and vandalism. General maintenance is expected to be carried out on an ongoing basis to ensure that the main items listed in Table 4 are maintained annually and not allowed to go into disrepair.

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Table 4: Main items to manage in the general maintenance plan and the required standard.

No	Description	Required standard
1	Main forest road.	Maintain good surface dressing, free from potholes.
2	Roadside drains.	Allow to revegetate.
3	Roadside silt traps.	Effective. Water flowing. Not silted up.
4	Roadside dams.	Effective. Water flowing. Not silted up
5	Silt traps in buffer zones.	Effective. Water flowing. Not silted up.
6	Leaky dams in buffer zones.	Effective. Water flowing. Not silted up
7	Dams in buffer zones.	Effective. Water not flowing.
8	Silt traps in restored areas.	Effective. Water flowing. Not silted up.
9	Dams in restored areas.	Effective. Water not flowing.
10	Silt curtains.	Effective and securely in place.
11	Signage.	In good condition, not vandalised.
12	Dumping.	None on site. Remove when observed.
13	Vandalised signage.	Repair when observed.
14	Vandalised forest barriers.	Repair when observed.
15	Access for the public.	Adhere to open forest policy.
16	Restrict public access.	Adhere to Health & safety requirements.
17	Sondes.	Securely in place and operating effectively.

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5.0 Fire plan

The threat from fires is an annual threat in Connemara. For most of the year from June to February the threat is low but for the months from March to May, the threat is high. Between the months of March to May the vegetation is at its driest and most prone to fire. In addition, before it became illegal, the traditional practices of "setting fires" coincides with these months, and unfortunately this practice occurs illegally from time to time. For both of these reasons, the threat of fires needs to be taken seriously in Derryclare and managed.

Fires tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. For infrequent fires there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires, (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return when burning has produced a bare peat surface (Evans & Warburton, 2007).

Derryclare property lies with the Coillte management area called BAU2. This BAU has a designated fire plan and resources to tackle wildfires and Derryclare will remain part of this fire plan. These resources include a helicopter call out during the fire season, access to trained fire fighters, established access to local fire brigades, experienced volunteers, and access to the full range of firefighting equipment including fire trailers, beaters, PPE, drones, ATVs, pumps and generators.

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Fire plan – Derryclare

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A: Site Safety Rules

The following rules apply at all times

All firefighting volunteers must ...

- be fully trained (training provided by Coillte).
- wear their PPE at all times.
- check in and out with the attending forest manager.
- never work alone.
- ensure they can be contacted while on site.

Note: Failure to comply with the above site safety rules will result in volunteers been asked to leave the site.

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B) Safety During a Fire

A) While fighting a fire:

- Know your limitations. Pace yourself. Do not overdo it.
- Know where you are at all times, and who you are with.
- Know what group you are in and how many people are in that group.
- Do not wander away from the group.
- Ensure that adequate supply of water and food is available.
- Be conscious of escape routes.
- Return to assembly point and sign off with the fire coordinator.

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C) During the fire period:

- Have in your car your PPE, fire plan contact numbers, change of clothes and an adequate supply of drinking water.

- Keep mobile phones charged. Let people know where you are working.

- Be familiar with the fire plan, especially the HIRA.

- Know where the beaters are stored. Carry a few in the car during extreme conditions.

- Carry a small amount of extras in the car such as a pruning saw, hack saw, vice grips, buckets, torches etc.

- Get to know the main danger areas and know your way around them.

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D) If you hear of a fire:

- Check out the fire as quickly as possible. Get as much information as possible.

- Contact the relevant manager before you attempt to tackle the fire.

- Do not fight the fire on your own.

- False alarms are common. It is better to be safe than sorry.

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E) Contact numbers

Not provided HERE due to GDPR reasons

Numbers issued to relevant personnel during the fire season

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F) Hazard Identification and Risk Assessment (HIRA)

OPERATION: Forest Fires **LOCATION:** North Mayo **ACTIVITY:** FIRE FIGHTING

No	HAZARDS	CONSEQUENCES	RISK			CONTROLS	PERSON RESPONSIBLE	R
			S	L	N			
1	Terrain Rough ground • Soft areas • Deep drains • Banks/walls/fences	Slip, trips and falls. Minor to serious injury	M	H	1	• Be vigilant • Walk with care • Ensure good footwear • Carry torches at night time • Maintain constant contact with team members	Operator	L
2	Lone Working	Serious Personal Injury	H	H	1	• Never work alone • Stay in close proximity to team • Maintain constant contact with team members • Do not detach from team unless planned	Operator	L
3	Insufficient/Inadequate training	Minor/Serious Injury	H	H	1	• All staff to have completed fire training course • All staff involved in fire drill at start of each year • Adhere to training instructions	Operator	L
4	Petrol Transport and Storage	Explosion/personal injury	H	M	1	• Max of 20 litres in two suitable stopped metal containers marked Petroleum Spirit • Store safe distances from fire	Operator	L
5	Handling foam concentrate	Irritation to skin and eyes	M	H	1	• Wear waterproof gloves S.T.C boots and face shield • Wash out eye immediately in the event of contact	Operator	L
7	Reeling in hose, moving pump unaided	Back injury – serious	H	M	1	• Use purpose built reel • Operator trained in manual handling technique • Moving pump – 2 man job	Operator	L
8	Change in wind direction	Isolation, disorientation and smoke inhalation	M	H	1	• Be vigilant for change in wind direction • Move to avoid smoke • Always work in teams	Operator	L
9	Mechanical Site firefighting with ATV	Serious/fatal injury to operator Serious/fatal injury to persons close by	H	H	1	• Only trained/experienced and competent operators to operate machinery • Observe risk zone • Wear high visibility vest	Operator	L

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ASSESSMENT COMPLETED BY _____ SEEN BY _____

DATE _____ DATE _____

G) The penalties for illegal burning

Under section 39 of the Wildlife Act 1976, as amended by the Wildlife (Amendment) Act 2000, a person shall not burn any vegetation growing within one mile of – a wood which is not the property of such person, or other lands restricted by the Wildlife Acts, unless they have provided written notice of their intention to a Garda station in a Garda district in which the land they intend to burn is situated.

Notice of intention to burn must be provided between seven and 35 days prior to the burning.

Failure to provide written notice is an offence carrying penalties,

upon conviction, of;

- **first offence** – fine not exceeding €634.87 or to imprisonment for a term not exceeding three months or to both;

- **second offence** – fine but not exceeding €1,269.74 or to imprisonment for a term not exceeding six months or to both, and third offence – fine not exceeding €1,904.61 or to imprisonment for a term not exceeding twelve months or to both.

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H) Reporting fires to the Guards

Important things to know...

1. Campwest do not report fires to the Guards.
2. The guards will only investigate a fire if it is logged on their PULSE system.
3. To log a fire on PULSE all fires within one mile of a forest must be reported to an Garda.

How to report a fire

1. Call the Garda station nearest to the fire.

2. When reporting there are 3 key pieces of information you must provide:

- Report that an offence is occurring (burning within 1 mile of a forest);
- Report the townland the fire is in;
- Report the nearest largest town.

3. When the fire report is completed in the office forward the report and a map of the area to Inspector Joe McKenna.

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References

Campbell D et al, 2019. Peatlands and forestry. IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. Available from https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2019-11/CoI%20Forestry%20and%20Peatlands%20file%20size%20reduced.pdf

Cross, J.R. (1973) The ecology and control of Rhododendron ponticum (L.) with special reference to the Killarney National Park. PhD Thesis, University of Dublin, Trinity College

Edwards, C. (2006). Managing and controlling invasive rhododendron. Forestry Commission Practice Guide.

Evans, M.G and Warburton, J. (2007) Geomorphology of upland peat: erosion, form and landscape change. Oxford: Blackwell Publishing.

Higgins, G.T. (2008) Rhododendron ponticum: A guide to management on nature conservation sites. Irish Wildlife Manuals, No. 33. National Parks and Wildlife Service.

Lindsay, R. A. (2010). Peatbogs and carbon: a critical synthesis to inform policy development in oceanic peat bog conservation and restoration in the context of climate change. Commissioned Report to the Royal Society for the Protection of Birds (RSPB).

Rotherham, I.D. (1983). The ecology of Rhododendron ponticum with special reference to its competitive and invasive capabilities, Department of Botany, University of Sheffield.

Shaw, S., Wheeler, B., & . (1994). Monitoring Raised Bogs., Rep. No. 189. English Nature, Peterborough.

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APPENDIX 5

GEOLOGICAL, HYDROLOGICAL, & HYDROGEOLOGICAL RESPONSES TO SUBMISSIONS PREPARED BY HES

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Galway County Council

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GEOLOGICAL, HYDROLOGICAL & HYDROGEOLOGICAL RESPONSES TO SUBMISSIONS IN RELATION TO DERRYCLARE WILD WESTERN PEATLANDS PROJECT, CO. GALWAY – (PLANNING REF: P.23/60)

DRAFT REPORT

Prepared for:
Galway County Council

Prepared by:
Hydro-Environmental Services

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AUTHOR(S):	**MICHAEL GILL** **CONOR MCGETTIGAN**
SIGNED:	Michael Gill **Michael Gill B.A., B.A.I., M.Sc., MIEI** **Managing Director – Hydro-Environmental Services**

Disclaimer:
This report has been prepared by HES with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our terms and conditions and taking account of the resources devoted to it by agreement with the client. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. The flood risk assessment undertaken as part of this study is site-specific, and the report findings cannot be applied to other sites outside of the survey area which is defined by the site boundary. This report is confidential to the client, and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by MKO to respond to a further information request issued by Galway County Council on 19th April 2023 for the proposed Derryclare Wild Western Peatlands Project, Co. Galway (Planning Ref P23/60).

This report responds to Item 3 of the further information on queries relating to the geological, hydrological and hydrogeological environments.

1.2 STATEMENT OF QUALIFICATIONS

Hydro-Environmental Services (HES) has extensive hydrological and hydrogeological experience relevant to this project. Upland hydrology, forestry and windfarm related drainage design are core areas of business for HES. HES routinely completes environmental impact assessment reports in terms of hydrology and hydrogeology for proposed developments on peatlands (forestry and renewable energy projects). HES also specialises in the area of wetland hydrology, ecohydrology and bog restoration and has worked with National Parks and Wildlife (NPWS) on several bog and wetland restoration projects. HES has extensive experience in surface water drainage design and surface – groundwater interactions.

HES have worked on over 100 wind farm projects in Ireland and Northern Ireland. Many of these were situated on peatlands and required assessments of existing drainage features, streams and water quality data. HES work at all stages of wind farm developments including feasibility stage, layout design & preliminary drainage design/planning stage, and also at construction management stage. Wind farm drainage design/management requires experience both as a civil/drainage engineer, a hydrologist and as a hydrogeological specialist. HES have these combined experiences and expertise which are also relevant to this project.

HES's experience covers the key area of water quality and drainage controls and mitigation during all phases developments. HES work at EIAR/planning stage to assist with development of the optimal site layout which involves development of hydrological constraints maps and interaction with geotechnical and ecological specialists and with site designers. HES also provide a follow-on consultancy service (if planning is granted and the development proceeds to construction) of detailed drainage design and construction management for drainage during development/construction stage. This practical on-site experience is invaluable as it has led to the development of improved preliminary and detailed drainage layouts and also many improvements/optimisations to standard peatland drainage mitigation measures.

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1.3 SUMMARY OF KEY MATTERS RAISED

HES have reviewed the Galway Co. Co. RFI (dated 19th April 2023) along with the submission made by National Parks and Wildlife (NPWS) (dated 12th April 2023). The key issues raised by the Planning Authority and NPWS regarding drainage management and surface water quality are largely contained within request Item 3 and are summarised in **Table A**.

Table A: Summary of FI request Item 3

Key Matter Raised	Item Ref
The Local Authority requests robust scientific evidence that the proposed methodologies of drain blocking, damming, drain reprofiling, stump flipping, surface smoothing, mulching and cross-tracking do not pose risks of water quality impacts.	3 (a)
Insufficient baseline water quality monitoring.	3 (b)
Information gap in relation to the rainfall data utilised to demonstrate the pluvial impact of water drainage.	3 (c)
Additional detailed should be presented in the Flood risk Assessment including the additional loading to existing surface water features and the ability of harvest blocks to accommodate the predicted rainfall.	3 (d)

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2. RFI ITEM RESPONSE

2.1 ITEM 3 (A)

Item 3 (a) of the RFI issued by Galway County Council on 19th April 2023 is reproduced below:

> *"The Irish Peat Conservation Council (IPCC) raised concerns within their initial scoping response regarding the adequacy of current "best practice approaches" to assessing peat strength and stability, these have been found wanting, owing to numerous landslides across the country. This in combination with the concerns raised by the DHLGH regarding using untrialled and untested methods of peat restoration in an upland area of the west of Ireland; the applicant is requested to provide sufficient supporting evidence demonstrating the trailing and testing of the proposed methods, including the provision of likewise case studies, providing the Local Authority with robust scientific evidence that the proposed methodologies of drain blocking, damning, drain reprofiling, stump flipping, surface smoothing, stump mulching and cross-tracking and do not pose detrimental risks of peat disturbance, peat erosion, peat stability and water quality impacts as a direct result of the development. The supporting evidence should be comprehensive and include the appropriateness of the proposed drain blocking using dams on slopes of greater than 6 degrees, the project proposes these works on slopes of 10 degrees which is contrary to current recommendations and untested in Ireland. Please comprehensively address this concern."*

2.1.1 Item 3 (A) Response

With respect to potential water quality effects which may arise from drain blocking, damming, drain reprofiling, stump flipping, surface smoothing, stump-mulching and cross-tracking, detailed mitigation measures are presented in the EIAR Chapter which ensure the protection of surface water quality and compliance with WFD objectives. A detailed Hydrological Monitoring Plan for the project is also attached in **Appendix I**.

Issues with respect to slope stability and associated implications for the project viability have been considered carefully at all stages of this project. A detailed Peat Stability Risk Assessment (PSRA) has been completed by Fehily Timoney (FT) for the Proposed Project. The PSRA is attached to the EIAR as **Appendix 7-1** and concluded that the site has an acceptable margin of safety, is suitable for the proposed peatland rehabilitation works and is considered to be at low risk of peat failure. The PSRA also includes recommendations and mitigation measures for rehabilitation works in peatlands, all of which will be implemented to ensure that the proposed works adhere to an acceptable standard of safety.

2.2 ITEM 3 (B)

Item 3 (b) reads as follows:

> "The applicant should have monitored the water quality within and connected to the site in more detail to ascertain baseline quality information to inform both the EIAR and in the assessment of risk in relation to the Appropriate Assessment. Baseline data should be collected over an appropriately representative period, combining both manual and automatic monitoring triggered by flow and submitted in support of the application."

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2.2.1 Item 3 (B) Response

The baseline surface water quality of the site is presented in Section 9.3.6 and Section 9.3.13 of the EIAR.

Section 9.3.6 presents surface water quality data obtained specifically for the EIAR study. The data presented in this section comprises of grab samples (2 no. rounds of 5 no. samples completed by RPS on 10th August and 8th October 2022) and field hydrochemistry (14 no. locations monitored by HES on 22nd and 23rd of November 2022). We acknowledge that the results presented in Section 9.3.6 represent water quality data from grab sampling.

However, long-term water quality data for the baseline environment is also presented in Section 9.3.13 of the EIAR. In this section, the Water Framework Directive (WFD) status of the waterbodies within and connected to the project site is discussed. Under the WFD, waterbodies can be awarded 1 of 5 no. status ranging from "Bad" status to "High" status. Waterbodies are assigned a status based on monitoring of biological elements (*i.e.* fish, macro-invertebrates etc.) and supporting elements (hydromorphology, nutrients, dissolved oxygen etc.). Each of these elements contribute to the overall WFD status of a waterbody, with the lowest common denominator rule being applied, whereby the lowest scoring element denotes the overall status of a waterbody. The EPA completes extensive monitoring work in support of the WFD and the frequency of monitoring is outlined in **Table B** and corresponds to the minimum monitoring frequencies as recommended in Annex V of the WFD.

Table B refers to 2 no. types of monitoring programme completed by the EPA: Surveillance Monitoring (SM) and Operational Monitoring (OM). Surveillance Monitoring provides a comprehensive and long-term picture of water body status while Operational Monitoring assesses any changes in the status of the waterbody.

According to www.catchments.ie there are a total of 10 no. National Water Monitoring Stations located on Derryclare Lough downstream of the project site (refer to **Figure A** below). Therefore, the "High" status achieved by the Derryclare lake waterbody has been assigned following water quality monitoring at these stations as per the frequencies outlined in **Table B**. Given the wide range of parameters and the frequency of monitoring completed by the EPA in order to assign a WFD status to Derryclare Lough, we consider that the WFD status provides sufficient water quality information for this waterbody and any additional sampling would be superfluous. Whilst we note that there are no National Water Monitoring Stations located on Lough Inagh, we consider that the grouping of its WFD status with that of Derryclare Lough is adequate. Given the close proximity and similarity of these two lake waterbodies, any additional sampling at Lough Inagh is unnecessary. We acknowledge that there are no EPA monitoring stations on the small streams which drain the site but additional monitoring has been completed to address this issue – see below.

Therefore, the WFD status of the lake waterbodies in the vicinity and downstream of the site are assigned based on the results of an extensive monitoring programme which combines biological, hydromorphological, physico-chemical monitoring. Consequently, it can be concluded that the WFD status of the lake waterbodies presented in Section 9.3.13 presents the results of long-term monitoring in the vicinity of the site and is sufficient for the EIAR process.

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Furthermore, additional monitoring has been completed since October 2022 in order to provide additional information relating to the baseline hydrological environment. This additional monitoring comprised of monthly grab samples at 5 no. locations (4 on local streams within the site and 1 on Lough Inagh) and Biological Quality Surveys at 4 no. streams within the site. The results of the biological surveys ranged from High (Q4-5) to Moderate (Q3-4). The high status was achieved in the upper reached of a watercourse and the status of this watercourse decreased further downstream. Meanwhile, the results of the monthly grab samples from January to April show that the recorded parameters in the local watercourses and Lough Inagh are typically below the respective EQS apart from elevated concentrations of zinc. The waters have low alkalinity, are very soft, have low nutrient concentrations and

are acidic with low pH values. The full results of this monitoring is presented as an appendix to the monitoring plan (attached as **Appendix I**).

Furthermore, it is fully intended to complete a detailed monitoring plan in advance of the proposed works. This monitoring plan includes general water quality monitoring during the Pre-Construction and Post-Construction phases, with more intensive monitoring completed during the Construction Phase. During the Pre-Construction Phase it is proposed to record key hydrochemical parameters (temperature, conductivity, and turbidity) through the use of automated probes at 15 minute intervals. In addition, monthly grab samples will be taken for phosphorous and annual biological monitoring will be undertaken. The data from the Pre-Construction monitoring will furthermore aid the characterisation of the baseline hydrological environment. The detailed monitoring plan is attached as **Appendix I**.

Therefore, given the combination of the monitoring completed as part of the EIAR study (field hydrochemistry and grab sampling) and the long-term monitoring completed by the EPA as part of the WFD process, we consider that the baseline water quality information presented in Chapter 9 is sufficient for the EIAR process. Furthermore, once permission is received for the Proposed Project, additional water quality monitoring will be completed in advance of any works and this data will be used to further characterise the baseline hydrological environment.

Table B: Frequency of monitoring for each quality element in the national surface water WFD monitoring programme (EPA, 2021)

Water Quality Element	Water Category	
	Rivers	**Lakes**
Biological		
Macroinvertebrates Fish Aquatic Plants	Every 3 years (annual monitoring of macroinvertebrates in priority areas)	Every 3 years
Phytobenthos	Annual (SM))	Twice per annum every 3 years (SM)
Phytoplankton	-	Twice per annum (SM)
Hydromorphology		
Hydromorphology	Every 6 years	Every 6 years
Priority Substances		
Priority Substances	12 times per annum every 6 years	12 times per annum every 6 years
Physico-Chemical		
Nutrients Oxygen Conditions Acidification	5 times per annum (OM) 12 times per annum (SM)	4, 6 or 8 times per annum (OM) 12 times per annum every 3 years and as per OM frequency in other years (SM)
Specific Pollutants	12 times per annum every 6 years	12 times per annum every 6 years

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Figure A: National Water Monitoring Stations (www.epa.ie)

2.3 ITEM 3 (C)

Item 3 (c) reads as follows:

> "It is noted that the rainfall data utilised to demonstrate the pluvial impact of water drainage across the site relies on data from a monitoring station in Claremorris and data collated from Met Eireann from 1965-1985, where the extents of extreme rainfall as a result of climate change would not have been recorded. This information gap alongside the relatively high levels of existing peat saturation combined with the proposed drain blocking, removal of trees & exposure of bare peat needs to be adequately analysed and studied to determine the risks posed and mitigation required to protect peat stability on-site and avoid any resultant impact on Population and Human health, biodiversity, land, soil and water quality as well as in the adjoining SAC. The applicant is requested to provide site specific standard rainfall data from recent monitoring carried out over an appropriate period across the application site, this should collate alongside the peat depths, saturation levels in corresponding months and results of the FRA. (requested on item d)."

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2.3.1 Item 3 (C) Response

Rainfall Data

The RFI suggests that the rainfall utilised in the EIAR chapter was from a monitoring station in Claremorris and relied on data collated from Met Eireann from 1965 to 1985. This statement is incorrect.

The data from Claremorris weather station was utilised solely with respect to average potential evapotranspiration. Average potential evapotranspiration data is only available for 14 no. weather stations in the Republic of Ireland. Whilst we acknowledge that this weather station is located ~54km northeast of the project site, it is the closest weather station for which evapotranspiration data is available. As stated in Section 9.3.2, the annual potential evapotranspiration at Claremorris is 408mm/yr. Other weather stations on the Atlantic Coast for which potential evapotranspiration data is available include Bulmullet and Shannon Airport, located ~80km northwest and ~100km to the southeast of the project site respectively. The annual potential evapotranspiration at these locations is 527mm/yr and 543mmm/yr. Despite the differences in potential evapotranspiration between these 3 no. rainfall stations, the data from Claremorris is chosen due its proximity to the project site.

With respect to the rainfall data presented in Section 9.3.2 of the EIAR, the rainfall data was sourced from the nearest available rainfall station, *i.e.* Ballynahinch rainfall station, located ~7km to the southwest of the project site. We recognise that Ballynahinch station closed in 1985. However, Met Éireann have modelled the 30-year average rainfall for this station for the period from 1981 to 2010 (www.met.ie). The 30-year annual average rainfall for the period from 1981 to 2010 for Ballynahinch rainfall station was utilised in the assessment of runoff and pluvial effects associated with the Proposed Project.

In addition, Section 9.3.2 of the EIAR presents rainfall return periods for the project site. Rainfall return periods were sourced from Met Éireann (www.met.ie) which uses a depth duration frequency model to estimate point rainfall frequencies for a range of durations for any location in Ireland. Site-specific rainfall return periods specific to the project site are presented in the EIAR.

Nevertheless, we also recognise that the standard average annual rainfall (SAAR) of 1,211mm/yr referenced in the EIAR underestimates the actual rainfall at the project site. Met Éireann now provide a grid of SAAR for the entire country for the period of 1991 to 2020. Based on these site-specific modelled rainfall values, the SAAR at the project site ranges from 2,283 to 2,489mm/year, with an average of 2,429mm/yr.

An updated water balance is provided below, assuming an average annual rainfall of 2,429mm/yr.

Effective rainfall (ER) = SAAR – AE
= 2,429mm/yr – 387mm/yr
ER = 2,042mm/yr

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Groundwater recharge coefficient estimates from the GSI (www.gsi.ie) vary across the project site from 4% where the project site is overlain by peat to 85% where bedrock outcrop is present. Due to the extensive coverage of blanket peat at the site, the low permeability of the bedrock aquifers and the sloping nature of the topography, a recharge coefficient of 10% is taken for the project site. Based on this coefficient, an estimate of 204.2mm/year average annual recharge is given for the project site. This means that the hydrology of the project site is characterised by very high surface water runoff rates and very low groundwater recharge rates. Therefore, conservative annual recharge and runoff rates for the project site are estimated to be 204.2mm/yr and 1837.8mm/yr respectively.

SAAR and Implications for Peat Stability Assessment

The rainfall depths referenced in Chapter 9 of the EIAR has no direct implications for the Peat Stability Risk Assessment (PSRA) completed for the Proposed Project. The completed PSRA does not use standard annual average rainfall (SAAR) as an input parameter in the peat stability calculations. The slope stability calculations are completed assuming a fully saturated peat profile (i.e. the water table is conservatively assumed to be at ground level), and a surcharge of 10kPa (*i.e.* an additional surface load) is applied to each analysis point. This surcharge is equivalent to 1m of stored peat or 1m of water (simulated) above ground level (given the similar density of peat and water). Therefore, the peat stability risk assessment accounts for additional water load (from seasonal and temporal rainfall events) in this manner, and not directly by use of the SAAR rainfall value for the site.

2.4 ITEM 3 (D)

Item 3 (d) is reproduced below:

> "The application site including post operational needs to be fully assessed against the increased flood risk posed by the change of use of the land, including the changes to the management of the existing water courses and drainage flows within the application site. The FRA should examine the additional loading to the existing surface water features within the site, the ability of each harvest block to accommodate the predicted rainfall, including saturation rates of the peat, the structural capacity of the proposed dams (at the various locations) to accommodate predicted extreme pluvial events, as well as assessing the adequacy of the proposed silt traps and fencing and any additional mitigation measures which may be required)."

2.4.1 Item 3 (D) Response

Flood Risk

The purpose of the Proposed Project is to restore and rehabilitate the project site to Atlantic Bog and heathland habitats.

The project site was planted with coniferous forestry plantations in the 1960s. In order to facilitate the forestry operations at this time, the site was drained by inserting forestry drains, typically mound and ribbon drains, into the peat surface at ~15-20m intervals. The effect of this "draining" was that the water table in the peat bog was lowered, with water making its way into the forestry drains which in turn discharged into local watercourses and into Lough Inagh and Derryclare Lough. Following the change in land use at Derryclare to forestry, the Derryclare site retained less water than in its original undrained "natural" state. Furthermore, due to the current imposed forestry drainage system the local watercourses (*i.e.* mountain streams) likely respond more rapidly to rainfall events and likely have flashier hydrographs than would have occurred in its natural state.

With respect to the hydrological and hydrogeological environment, the overall aim of the Proposed Project is to restore the hydrological regime as much as practicable to its original state. Restoration and rehabilitation will place the existing peatland environments on a path towards naturally functioning peatlands.

Improvements in runoff volumes can be achieved through rehabilitation and restoration. The plans involve the rewetting of the drained peatlands (by increasing the saturation rates of the peat) through restoration works such as drain blocking, surface smoothing and re-profiling. These works will reduce surface water runoff from each harvest block, and on a wider scale increase the water storage capacity of the overall site. This will result in the hydrograph of nearby watercourses being less flashy, with a more gradual response to rainfall events. Therefore, these measures will reduce and delay the hydrograph peak on each of the local watercourses, and also reduce the flood risk downstream of the site.

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Furthermore, irrespective of the volumes of runoff from the project site, all runoff from the site enters either Lough Inagh or Derryclare Lough. These are a series of large, interlinked lakes, and they have a huge ability to buffer rainfall runoff. As a result, the potential for an increase in downstream flood risk as a result of the proposed project is negligible.

Structural Capacity of Dams

As detailed in Chapter 4 of the submitted EIAR, the slopes and sizes of the drains will be the deciding factors in selecting the dam material types and also the spacing of the dams.

The selection of dam materials will be based on the existing best practice bog restoration techniques and guidelines. Peat dams will only be used on a shallow slopes (<10° gradient), with plastic dams being used on steeper slopes. The spacing of dams will also improve the structural capacity of the dam by decreasing the loading an any one dam. The dam spacing should be between 7.5 m and 20 m on flatter ground, however, the frequency of dams should increase to between 5 m and 7 m on steeper sloping ground.

Adequacy of Silt Traps and Silt Fencing

As detailed in the EIAR, silt fences and silt traps will be installed at the outfalls of existing drains before the commencement of any works. In areas that are particularly susceptible to erosion (*i.e.* steeper slopes), it may be required to install double or triple silt fences. These measures follow all existing best practices and guidelines in relation to felling and bog restoration and will ensure the protection of downstream surface water quality.

With respect to the adequacy of these features, silt traps and silt fences are widely used during peatland restoration for the prevention of suspended solids entrainment in runoff. Silt traps/fences are incorporated into the Construction Phase for water quality protection only, and they serve no function in long term water attenuation within the Rehabilitation Plan. During the Construction Phase silt traps/fences will be regularly inspected to ensure that they are functional and turbidity will be measured downgradient of the works areas. Necessary repairs and maintenance will be completed when required following inspections. In the event that elevated turbidity concentrations are recorded downstream, all upstream silt traps and silt fences will be inspected and no additional works will be completed until necessary repairs are made and downstream turbidity concentrations return to baseline levels.

No additional mitigation measures are deemed necessary.

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Appendix I:
Derryclare Wild Western Peatland Project, Co. Galway.
Proposed Hydrological Monitoring Plan

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DERRYCLARE WILD WESTERN PEATLANDS PROJECT, CO. GALWAY
PROPOSED HYDROLOGICAL MONITORING PLAN

Prepared for:
Coillte Nature

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Prepared by:
Hydro-Environmental Services

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Signed:	Michael Gill **Michael Gill B.A., B.A.I., M.Sc., MIEI** **Managing Director – Hydro-Environmental Services**

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by Coillte Nature to prepare a Hydrological Monitoring Plan for the Derryclare Wild Western Peatlands Project, Co. Galway.

The monitoring plan defines hydrological monitoring proposals associated with the Derryclare Wild Western Peatlands Project. The aim of the project to restore and rehabilitate ~281 hectares (ha) of Atlantic Bog and heathland that is currently planted with lodgepole pine and Sitka spruce forests and managed for commercial forestry.

The hydrological monitoring plan will be implemented throughout the lifetime of the proposed project including a period of pre-construction monitoring, monitoring during the construction phase and operation phase (i.e. post construction) monitoring. The monitoring will determine the success rate of the proposed project by monitoring several key hydrological parameters before and after the proposed works. Any deviation from the baseline hydrological environment recorded during the operational phase will quantify the success of the project. Separately, monitoring will also be implemented during the construction phase for the protection of local surface water quality.

The project site at Derryclare lies to the west of Lough Inagh and Derryclare Lough in Connemara, Co. Galway. A site location map is shown as **Figure A** below.

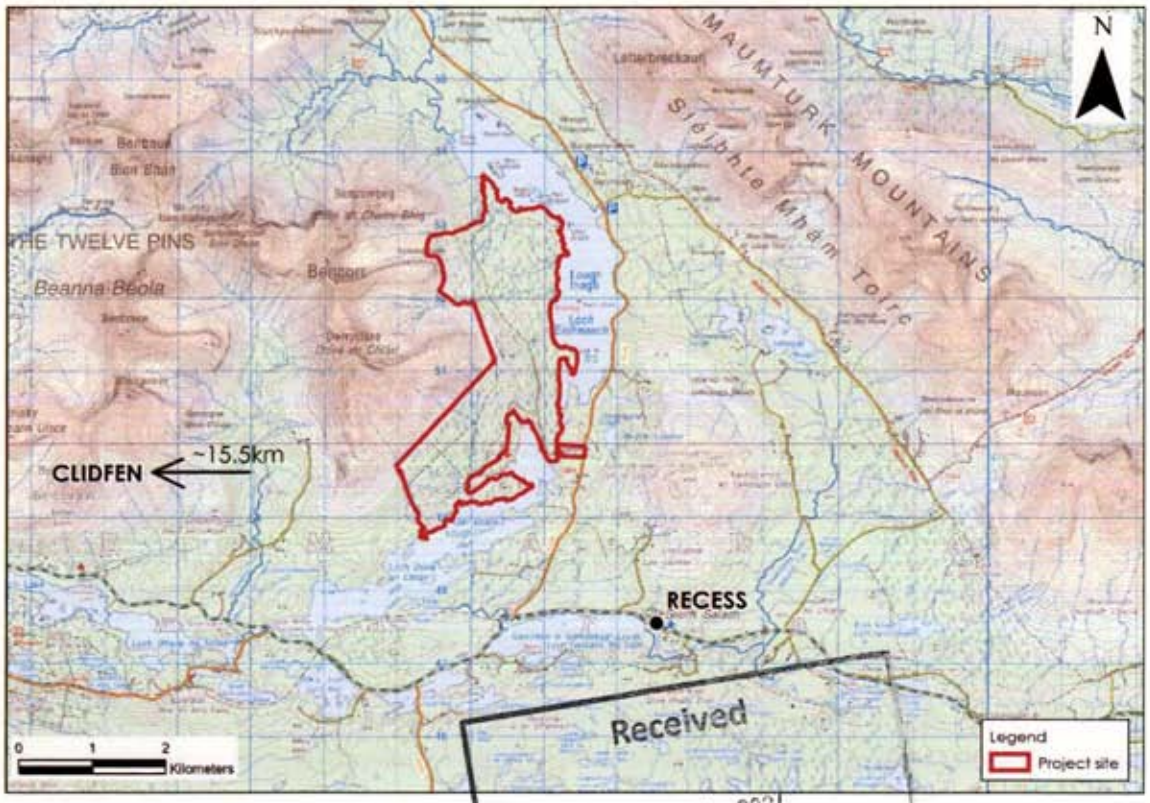

Figure A: Site Location Map

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1.2 STATEMENT OF EXPERIENCE

Hydro-Environmental Services ("HES") are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and

environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include upland hydrology and forestry and windfarm related drainage design. We routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types. We also specialise in the area of wetland hydrology, ecohydrology, and bog restoration.

This hydrological monitoring plan was prepared by Michael Gill and Conor McGettigan.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and other developments in coniferous forestry plantations and bogs in Ireland. Michael has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, Derrinlough WF, and Yellow River WF, and over 100 other forestry and wind farm-related projects. Michael also routinely provides hydrological/hydrogeological support and input to bog and wetland restoration projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with 3 years' experience in the environmental sector in Ireland. Conor holds an MSc in Applied Environmental Science and a BSc in Geology from University College Dublin. Conor has prepared the hydrology and hydrogeology chapter of EIARs for numerous projects including wind farms, grid connections and quarries. Conor has also been involved in several bog restoration projects including the restoration of Clonaslee Fen and Liffey Head Bog.

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2. SITE SETTING AND BASELINE CONDITIONS

2.1 INTRODUCTION

This section provides summary details on the existing environment and the hydrological/hydrogeological characteristics in the area of the project site.

2.2 PROJECT SITE DESCRIPTION AND TOPOGRAPHY

The Coillte property at Derryclare (the "project site") lies to the west of Lough Inagh and Derryclare Lough in Connemara, Co. Galway. The project site lies to the north of the N59 which joins Galway in the east to Clifden in the west.

The project site is owned by Coillte and was planted with Sitka Spruce and Lodgepole Pine in the 1960s. The overall Coillte landholding at Derryclare is ~567ha with the majority of the project site being dominated by coniferous forests (76%). The forestry plantations at Derryclare are of low to moderate productivity. Approximately 6% of the project site is unplanted, comprising of bog or wet heath habitats or is located along riparian buffer zones. An additional 18% of the forest cover has been felled or burnt and is reverting naturally wet heath or blanket bog.

The project site can be accessed from the R344, which branches off the N59 to the southeast of the project site and extends northwards travelling to the east of Derryclare Lough. A forestry track extends westwards from the R344 into the project site between Lough Inagh and Derryclare Lough. The project site is currently served by approximately 6.8km of forestry roads and tracks.

Topography of the project site is highly variable, ranging from 10-180mOD (meters above Ordnance Datum). The project site lies on the eastern slopes of Derryclare and Bencorr mountains with topography sloping steeply to the east towards Lough Inagh and Derryclare Lough. The western section of the project site contains the steepest gradients. Meanwhile, the eastern section of the project site, adjacent Lough Inagh and Derryclare Lough, is comparatively flatter.

2.3 PROJECT SITE – ENVIRONMENTAL SETTING

2.3.1 Geology

The published soils (www.epa.ie) maps show that the project site is predominantly overlain by blanket peat (BktPt) with some acid shallow, rocky, peaty mineral soil (AminSRPT) located on the higher ground in the west.

The published subsoils map (www.gsi.ie) shows that the north of the project site, along the western shores of Lough Inagh, is underlain by blanket peat (BktPt). Further south, till derived from metamorphic rocks (TMp) is mapped along the western shores of Derryclare Lough. Meanwhile, bedrock outcrop or subcrop (Rck) is mapped on the elevated ground in the west of the project site.

Soils and subsoils have been verified at the project site by intrusive site investigations completed between Summer 2021 and Winter 2022 (RPS, FI). The recorded peat depths range from 0.1 to 4.7m, with peat at the project site being typically shallow – 81% of peat probes recorded peat depths of less than 2m. The peat is underlain by till or solid bedrock.

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2.3.2 Hydrology

The project site lies on the eastern slopes of Derryclare and Bencorr mountains and on the western shores of Lough Inagh in the north and Derryclare Lough in the south. The project site

drains to these 2 no. lake waterbodies via several mountain streams. These streams rise on the mountains to the west of the project site and flow to the east, through the project site, before discharging into the adjacent loughs.

Detailed drainage maps for the project site have been produced by HES using EPA/OSI mapped watercourses, aerial photography, field mapping and Lidar data.

Within the project site there are also numerous manmade drains that are in place predominately to drain the forestry plantations. The current internal forestry drainage pattern is influenced by the topography, peat subsoils, layout of the forest plantation and by the existing road network. The forestry drains are the primary drainage routes towards the natural streams at the project site.

Recent hydrological monitoring completed as part of the EIAR included (refer to **Figure B**):

- Surface water flow monitoring was completed at 12 no. locations within the project site by HES (SW1-SW14, no flow monitoring was completed at SW2 or SW9) on 22nd and 23rd November 2022.
- HES also completed field hydrochemistry analysis was completed by HES at 14 no. locations.
- RPS completed grab sampling at 5 no. locations (P1-P5) on 2 no. occasions (10TH August and 08th October 2022).

The following additional monitoring has also been completed since January 2023 (refer to **Figure B**):

- Coillte have completed monthly grab sampling at 5 no. locations (P1-P5).
- Biological Quality Surveys were completed at 4 no. locations (DB2-DB4, and DB6) by Mayfly Ecology.

Summary of Recent Monitoring Results:

- A large range of flow volumes (2L/s to 2,000L/s) were encountered.
- Field hydrochemistry parameters were as expected for mountainous streams on peatlands: Electrical conductivity (EC) ranged between 64 and 117µS/cm, % dissolved oxygen saturation was between 69 and 93% and the pH values were generally acidic, ranging between 4.2 and 6.9.
- Based on the RPS grab sampling (2022):
  - All suspended solids were below the S.I. 293/1988 threshold limit of 25 mg/L;
  - 9 out of 10 samples were found to be of High status with respect to Ammonia (S.I. 272/2009);
  - Nitrate was below to LoD (Limit of Detection) in all samples ((<0.51mg/l N);
  - All samples were found to be of High status with respect to Orthophosphate (S.I. 272/2009); and,
  - Total phosphorous concentrations were below the LoD in all samples.
- Based on the Biological Quality Surveys:
  - DB-2 achieved "Moderate" status i.e. Q3-4
  - DB-3 and DB-6 achieved "Good" status i.e. Q4
  - DB-4 achieved "High" status i.e. Q4-5.
- The Coillte grab sampling from Jan 2023 – April 2023 found that:
  - The waters have low alkalinity, are very soft, have low nutrient concentrations and are acidic with low pH;
  - All suspended solids concentrations were below the S.I. 293/1988 threshold limit of 25mg/L;
  - Only 1 of 16 no. samples was found to be above the Good status threshold with respect to Ammonia (S.I. 272/2009);
  - The concentration of orthophosphate in the 16 no. samples were ≤0.01mg/L and all samples achieved High status (S.I. 272/2009); and,

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- Zinc was elevated in all sites (P1-P5) with the average concentration ranging from 8.75µg/L at P3 to 19.67µg/L at P5.

The full results of the 2023 biological quality surveys and grab sampling is presented in the attached Biological and Chemical Monitoring of Surface Waters (**Appendix I**).

The locations of the recent surface water monitoring points are shown in **Figure B** below.

2.3.3 Hydrogeology

A shallow perched ground water table exists in the peat and is largely isolated from the underlying regional groundwater system (which occurs in the underlying bedrock).

Due to the extensive coverage of peat at the project site, combined with the low permeability of the bedrock aquifer and the sloping nature of the surface topography, groundwater recharge at the project site is limited and water is rapidly discharged to nearby forestry drains and natural streams.

Recent hydrogeological monitoring completed at Derryclare included:

- Installation of 27 no. piezometers at Derryclare in 2021 by RPS in order to record the elevation of the peat water table (note that 16 no piezometers are located within the proposed restoration areas i.e. study areas – see **Figure C**).
- These piezometers were dipped on 2 no. occasions in autumn 2021 (August and September).

Summary of Monitoring Results:

- The elevation of the peat water table ranged from 0 mbgl (metres below ground level) to 0.67mbgl.

The locations of the existing piezometer network within the proposed restoration areas of the project site are shown in **Figure C**.

2.3.4 Designated Sites

The project site is surrounded on all sides by the Twelve Bens/Garraun Complex SAC and pNHA (Site Code: 002031). While the project site is not located within any designated conservation site, direct hydrological connections exist between the project site and the Twelve Bens/Garraun Complex SAC and pNHA (Site Code: 002031). All watercourses draining the project site flow into Lough Inagh and Derryclare Lough which both form part of the SAC/pNHA.

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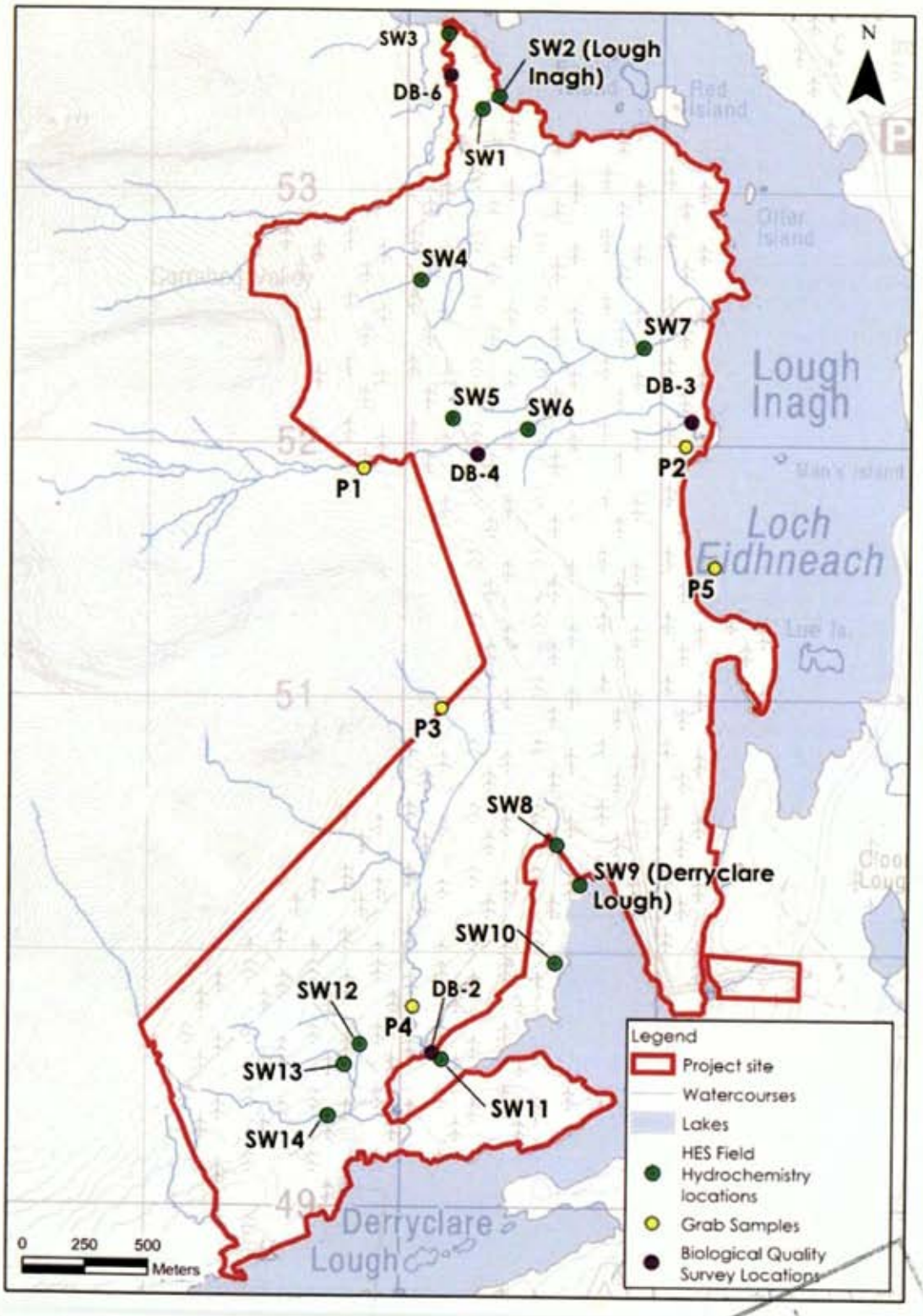

Figure B: Existing Surface Water Monitoring Locations

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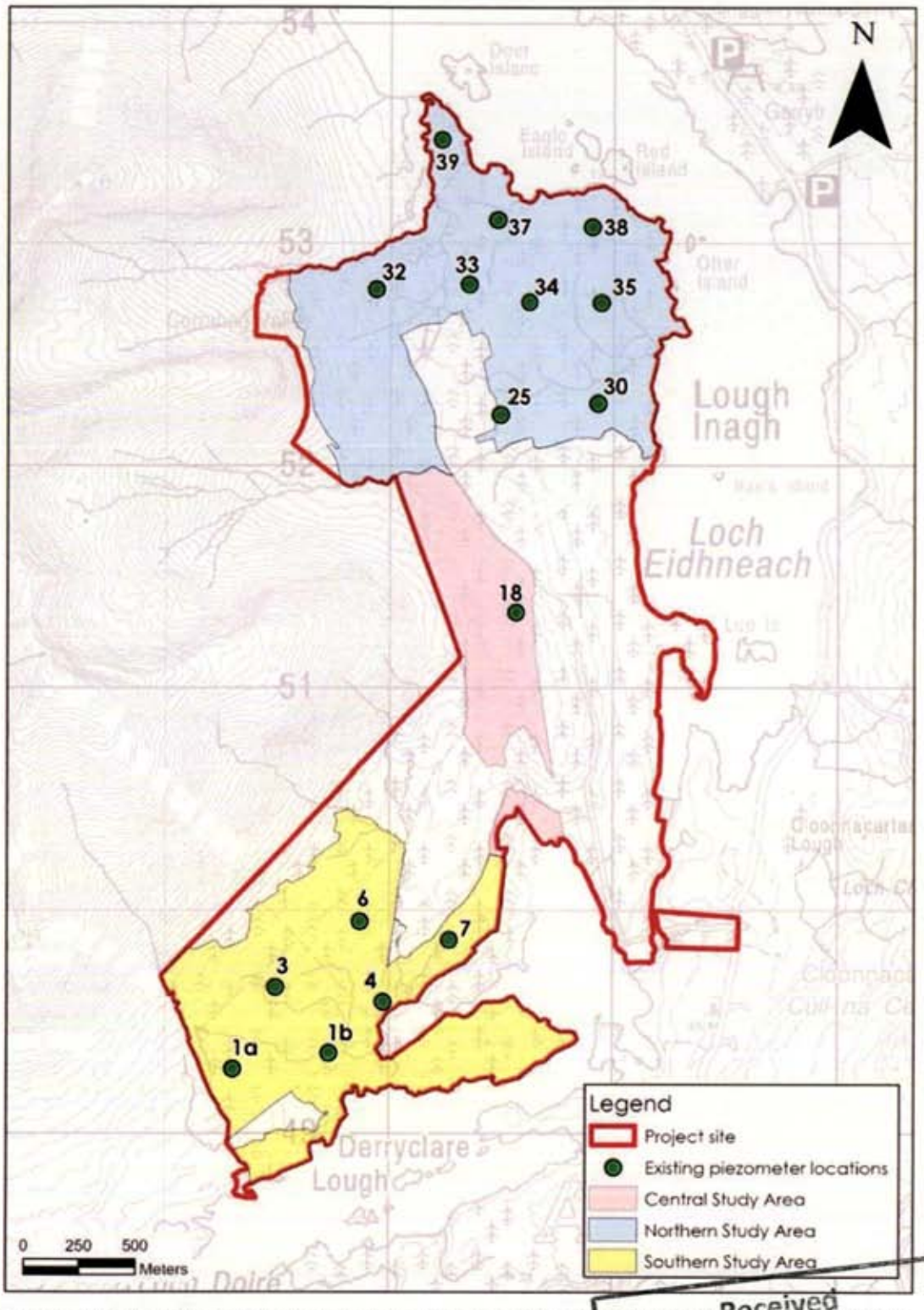

Figure C: Existing Ground Water Level Monitoring Network within study areas (RPS, 2021)

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3. PROPOSED PROJECT AND KEY HYDROLOGICAL ISSUES

3.1 PROPOSED PROJECT

The Derryclare Wild Western Peatlands Project (the "proposed project") aims to restore and rehabilitate ~281 hectares (ha) of Atlantic Bog and heathland that is currently planted with lodgepole pine and Sitka spruce forests and managed for commercial forestry. The Proposed Project will comprise of felling of the existing forestry plantations and a series of restoration works, including drain blocking and ground reprofiling designed to aid the restoration of the peatland at the project site. The Proposed Project also aims to convert ~62 Ha of coniferous forestry to native scrub woodland.

Coillte have subdivided the Derryclare landholding into a total of 22 no. forestry harvest blocks. A total of 2 no. harvest blocks (GY27_HB0025 and GY27_HB0026) are not included in the Proposed Project. GY27_HB0025, located in the south and west of the project site is already natural bogland and does not require restoration. Meanwhile, GY27_HB0026 located towards the center of the project site and along the western shores of Lough Inagh will be retained as commercial forestry. As part of the Proposed Project the other 20 no. harvest blocks will be subject to felling (where felling has not already been completed) and the implementation of restoration measures.

The harvest blocks proposed for restoration are spread out across the Derryclare Site and are located in different local surface water catchments. However, all restoration areas ultimately drain to Lough Inagh and Derryclare Lough.

3.2 REQUIREMENT FOR A HYDROLOGICAL MONITORING PLAN

3.2.1.1 Determining the Overall Success of the Restoration Project

Hydrological monitoring is an essential element of any peatland restoration project. It is of paramount importance in determining whether the restoration measures have been successful and whether the overall objectives of the project are being achieved.

The success of the Derryclare Wild Western Peatlands project will be determined by the comparison of several key hydrological characteristics between the operational phase (i.e. post-construction) and the pre-construction phase.

In terms of peatland restoration the key hydrological characteristics of any hydrological monitoring plan are:

Surface Water Flow Volumes:
Following rainfall events in a drained upland peatland site, such as that which currently exists at Derryclare, water quickly enters the surface water drainage network. Drained peatlands contain a dense network of manmade drains which in turn discharge to local natural watercourses. At Derryclare, the mound and ribbon forestry drains discharge into the numerous natural mountain streams which flow through the site before discharging into Lough Inagh and Derryclare Lough.

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This rapid discharge of water into the drainage network can be monitored through continuous water level and flow monitoring. The resulting hydrographs from a drained peatland show a rapid and flashy response to rainfall events with steep rising and falling limbs and a very short lag time between peak rainfall and peak discharge (refer to **Figure D**). In drained peatlands, water flows rapidly downslope following rainfall/storm events.

The aim of the Derryclare Wild Western Peatlands Project is to restore ~281ha of conifer plantation to peatlands. This will be achieved through restoration measures including drain blocking which aims to slow down the rate at which surface water is discharged downstream. Therefore, the hydrographs from a restored peatland will be more subdued in

comparison to a drained peatland, with more moderately sloping rising and falling limbs and an increased lag time between peak rainfall and peak discharge (refer to **Figure D**). In a restored peatland, more water will be retained by the bog and this water will be released at a slower rate and over a longer period of time in comparison to a drained peatland.

However, the hydrology of the restored peatland is unlikely to ever return to pre-drained characteristics (prior to the 1960s) which would have been characterised by a very subdued hydrograph.

Elevation of the peat water table:
Another hydrological parameter used to determine the success of peatland restoration projects is the elevation of the peat water table with respect to the ground surface.

In a drained peatland the elevation of the peat water table is subdued to the presence of surface water drains. The network of forestry drains at Derryclare have lowered the peat water table and the hydrograph of the peat water table is flashier, with sharp peaks corresponding to rainfall events and steep falling limbs (refer to **Figure D**). The capacity of the site to store water is reduced due to the rapid discharge of water to the forestry drain network.

The elevation of the peat water table in a restored peatland will be located closer to the ground surface in comparison to that of a drained peatland. The peat water table hydrographs will be more subdued in comparison to a drained peatland, with more moderately sloping rising and falling limbs (refer to **Figure D**).

However, the hydrology of the restored peatland is unlikely to ever return to pre-drained characteristics (prior to the 1960s) which would have been characterised by a peat water table close to or at the ground surface.

3.2.1.2 Surface Water Quality Monitoring During Construction Phase

Whilst the overall success of the project will be determined by monitoring during the pre-construction and operational phases and ultimately the comparison the key hydrological parameters between these phases, there is also a requirement for monitoring during the construction phase. During the construction phase the primary hydrological issues relate to water quality downstream of the work areas. The main potential issues include:

- Clear felling of the conifer plantation. Runoff from works areas has the potential to contain elevated concentrations of suspended solids and nutrients.
- Bog restoration measures including drain blocking and ground reprofiling can have a negative short-term effect on surface water quality. Runoff from works areas has the potential to contain elevated concentrations of suspended solids and nutrients.

The main concern raised by the NPWS is the potential effects that the proposed project may have on surface water quality within the project site, Lough Inagh and Derryclare Lough, and consequently, the Twelve Bens/Garraun Complex SAC.

Comprehensive mitigation measures have been proposed within EIAR and CEMP and will ensure that no surface water quality effects result from the proposed project.

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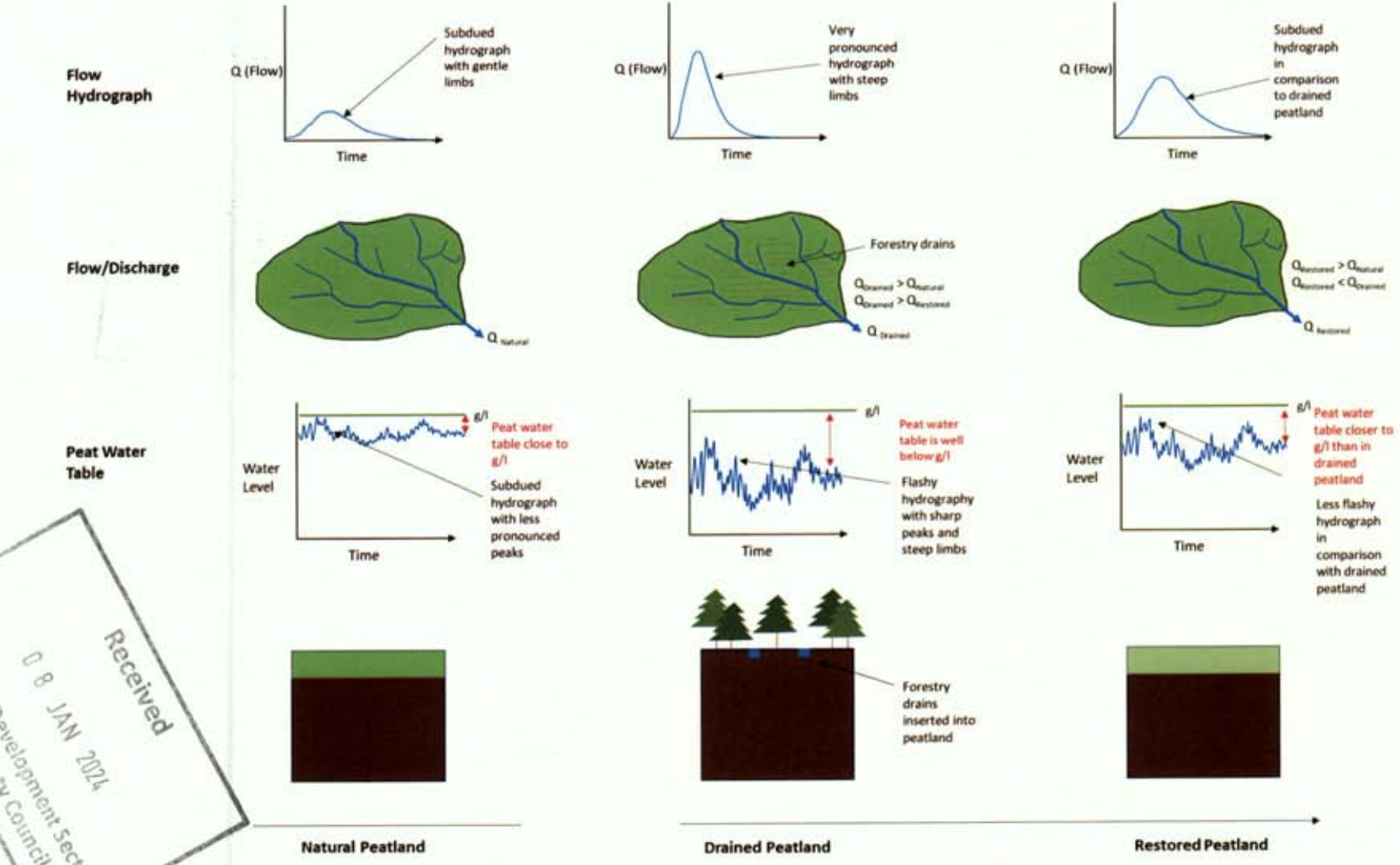

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Figure D: Summary of Hydrological Characteristics of Natural, Drained and Restored Peatlands*

*adapted from McCarter, C.P.R. and Price, J.S. 2015. The hydrology of the Bois-des-Bel peatland restoration: hydrophysical properties limiting connectivity between regenerates Sphagnum and remnant vacuum harvested peat deposits. Ecohydrology. 8, 173-187.)

4. PROPOSED HYDROLOGICAL MONITORING PLAN

4.1 PROPOSED HYDROLOGICAL MONITORING PLAN PHASES

This section sets out the proposed hydrological monitoring plan associated with the Derryclare Wild Western Peatlands Project.

The hydrological monitoring plan can be sub-divided into 3 no. phases as detailed below. These phases and the objectives of the hydrological monitoring plan for each phase are presented in **Figure E**.

4.1.1.1 Pre-Construction Phase

The success of the project will be defined by how the several key hydrological characteristics of the project site respond to the proposed restoration works.

In order to determine the success of the project from a hydrological perspective, the baseline hydrological environment will be monitored and characterised prior to the commencement of any restoration works. Coillte have committed to undertaking hydrological monitoring at the site for a period of **12 months** post-consent. The EIAR already provides sufficient information for the planning application and this monitoring plan is intended to be completed once consent for the project has been attained.

The key parameters to be monitored during this Pre-Construction phase of the monitoring plan include surface water flow volumes/discharge rates from the project site and the elevation of the peat water table with respect to the ground surface.

The data obtained during this phase of monitoring will later be compared with data from the operational phase in order to quantify positive changes in the hydrological regime as a result of the restoration works.

4.1.1.2 Construction Phase

During the construction phase, hydrological monitoring will focus on water quality.

Monitoring of surface water quality during the proposed works will facilitate the measurement of any immediate, short-term or temporary effects associated with the restoration works.

Monitoring can help determine the success of the proposed mitigation measures (as outlined in EIAR/CEMP)and inform whether works should be postponed if high levels of turbidity are recorded.

4.1.1.3 Operation Phase

During the Operation Phase (i.e. Post-Construction) hydrological monitoring will concentrate on the key parameters of flow volumes/discharge rates and the elevation of the peat water table with respect to the ground surface.

Operation Phase monitoring will determine the hydrological success of the overall restoration project by recording any long-term changes in the hydrological/hydrogeological environment and comparing the result with those recorded during the pre-construction phase i.e. the baseline hydrological environment. Post-works hydrological monitoring shall be completed for a period of **5 years**.

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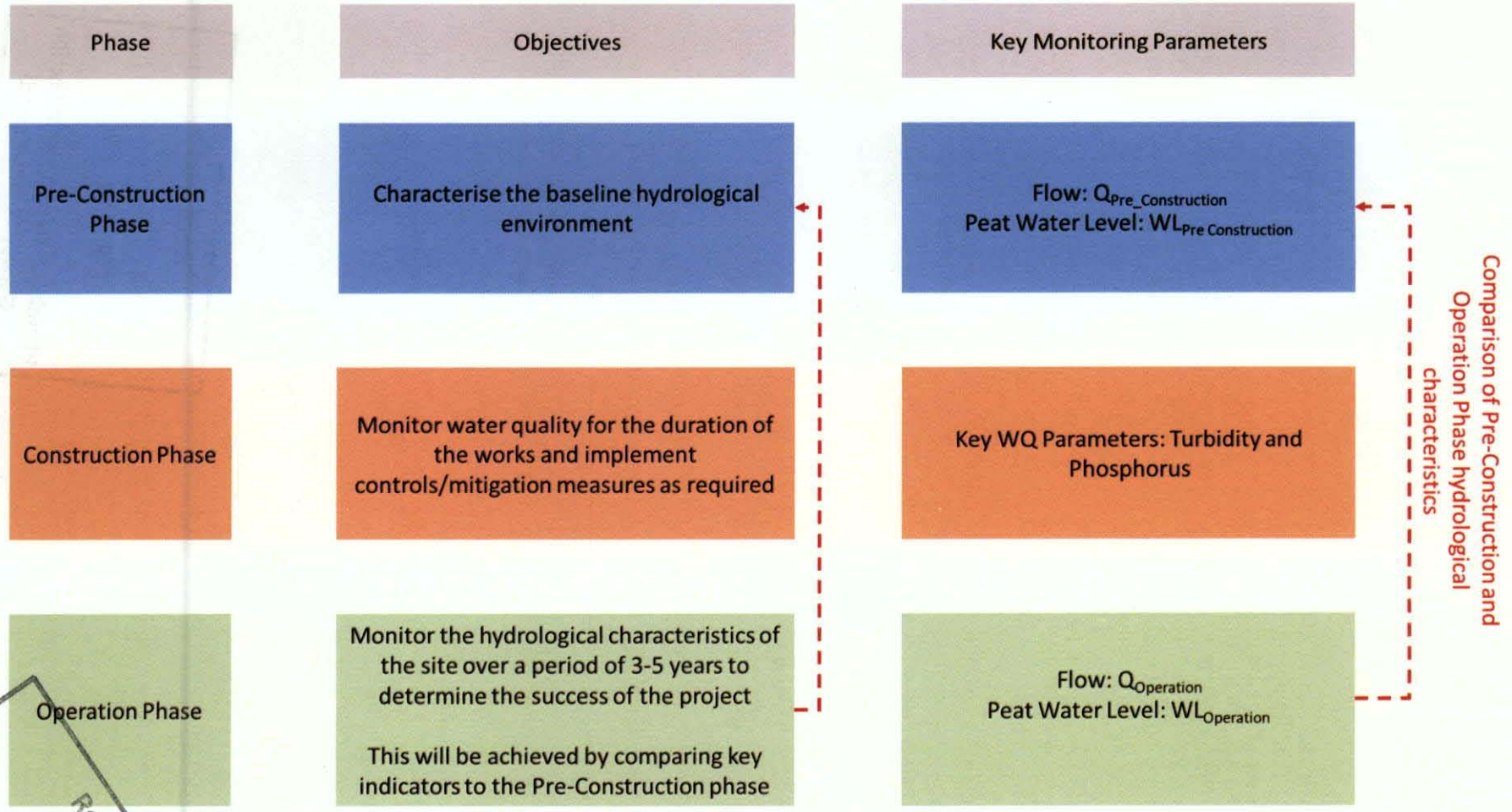

Figure E: Hydrological Monitoring Plan Objectives

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4.2 METHODOLOGIES

4.2.1.1 Water Flow Monitoring

Water flow monitoring will be completed throughout all phases of the monitoring plan (Pre-Construction, Construction and Operation).

It is proposed to monitor surface water flow volumes at 2 no. locations within the project site (SW1 and SW2). These monitoring locations have been chosen due to their location downgradient of much of the proposed work areas. Furthermore these proposed monitoring stations are situated on two of the main natural watercourses which flow through the project site. Therefore, the monitoring of the quantitative (flow) characteristics of these watercourses will help determine any changes in discharge rates which may result from the proposed restoration measures. The locations of these proposed monitoring stations are shown in **Figure H** below.

At these 2 no. locations surface and flow rates will be monitored in-situ through the use of an automated water level probe which will record the water level at regular intervals (typically every 15-minutes). A relationship will be established between water level and flow volumes through several manual flow measurements either recorded with a flow meter and/or through the installation of a flume or weir (refer to **Figure F**).

During all phases of the proposed project, the water level data will be downloaded from the loggers and analysed every 6 months.

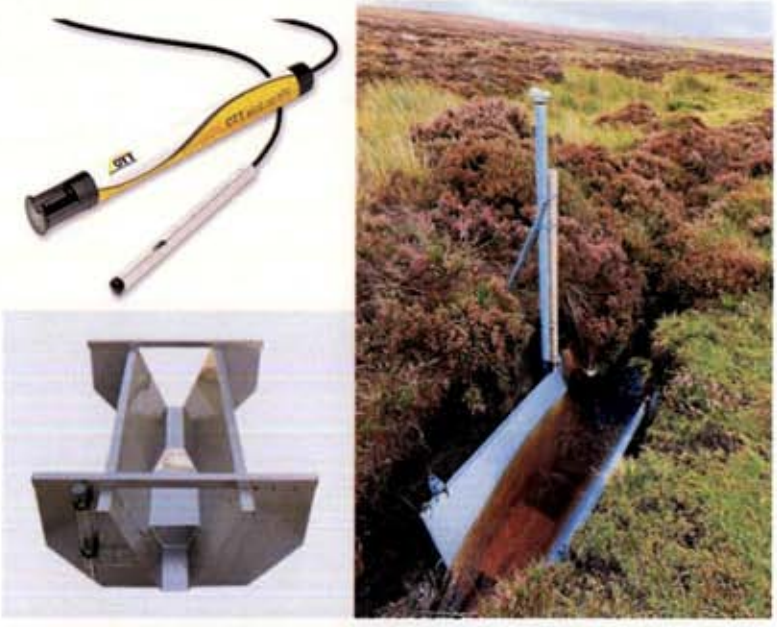

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Figure F: Example of Flow Monitoring

4.2.1.2 Water Quality Monitoring

General Water Quality Monitoring
In addition to the flow monitoring being completed at SW1 and SW2 during all phases of the proposed project, water quality monitoring will also be completed at these locations.

The loggers at SW1 and SW2 will also be fitted with several water quality probes which will record key hydrochemical parameters including temperature, pH, conductivity and turbidity.

The in-situ monitor could be installed with a telemetry which would allow real time data to be accessed remotely, although at a higher cost.

Similar to the flow data, this water quality data will be downloaded and analysed every 6-month during all phases of the proposed project.

In relation to phosphorus no sensor is currently available to provide continuous phosphorus measurements. Therefore, it is recommended to take monthly grab samples at each of these locations.

Monthly grab sampling will continue at the 5 no. monitoring locations (P1-P5) during all phases of the proposed project. 4 of these monitoring locations are situated on local watercourses while P5 is located on Lough Inagh. There is no monitoring being completed by Coillte on Derryclare Lough. Any monitoring here is deemed superfluous given the extensive monitoring being completed by the EPA. We also note that there has been a request for the EPA to increase monitoring frequency at Derryclare Lough.

Annual biological monitoring will also continue at 4 no locations (DB2-DB4 and DB6) during all phases of the proposed project.

Intensive Water Quality Monitoring During Construction Phase
More intensive surface water quality monitoring will be completed during the construction phase. This monitoring will be completed in addition to the general monitoring at SW1, SW2, P1-P5 and DB2-4 and DB-6 detailed above.

This intensive monitoring and associated mitigation measures are outlined in the EIAR/CEMP and include:

Turbidity:
It is proposed to complete continuous turbidity monitoring of surface watercourses downstream of the proposed work areas throughout the construction phase of the Proposed Project. This will be completed with the installation of automated water quality probes which will record turbidity and other hydrochemical parameters at regular intervals (typically every 15 minutes). These probes will be installed in natural watercourses downstream of work areas. The data will be processed and analysed at regular intervals and work will cease if elevated turbidity concentrations are recorded. In this event, all upstream silt traps and drainage routes will be inspected to identify the cause of the elevated turbidity levels. Work will not recommence until any issues have been resolved and the turbidity concentrations have returned to background concentrations.

In combination with the above, grab sampling will be completed before, during and after the felling activity (as is the norm in forestry operations). The 'before' sampling should be conducted within 4 weeks of the felling activity, preferably in medium to high water flow conditions. There is only the requirement for 1 no. "during" sample as most felling activity will occur in a short, concentrated time period. The 'after' sampling will comprise of at least 1 no. sample post felling or as many sampling events as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an effect has been shown).

Criteria for the selection of water sampling points include the following:

- Avoid man-made ditches and drains, or watercourses that do not have year round flows, i.e. avoid ephemeral ditches, drains or watercourses;
- Select sampling points upstream and downstream of the forestry activities;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the effect of land-uses other than forestry;
- Where possible, downstream locations should be selected: one immediately below the forestry activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no effect through dilution effect or

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contamination by other land-uses where impact increases at third downstream location relative to second downstream location); and,
- The above sampling strategy will be undertaken for all on-site sub-catchments streams where tree felling is proposed.

The final details defining this monitoring will be included in the Construction Stage CEMP which will be finalised in advance of any construction works.

Phosphorus:
Grab sampling before, during and after felling operations as detailed above. The monitoring will be used to ensure that the threshold of 62 mg/l Total P (EPA, 2001) for surface waters is not being exceeded. In addition, during the construction phase of the Proposed Project monthly grab samples will be taken from Lough Inagh (P5) to ensure there is no upward trend in total P occurring, and to demonstrate that the Site Specific Conservation Objectives (SSCOs) for nutrients are maintained (i.e. annual average total phosphorus (TP) ≤10 g/l TP, average annual total ammonia concentration should be ≤0.040mg/l N, and annual 95th percentile for total ammonia should be ≤0.090mg/l N) (NPWS, 2017). As stated above, any additional monitoring at Derryclare Lough is not necessary given the extensive monitoring already being completed by the EPA in this lake waterbody.

4.2.1.3 Proposed Peat Water Level Monitoring

Peat water levels will be monitored throughout all phases of the monitoring plan (Pre-Construction, Construction and Operation).

The proposed monitoring plan will utilise the existing piezometer network at Derryclare which was installed by RPS in 2021. A total of 16 no. piezometers have been installed with the proposed restoration areas of the project site (refer to **Figure C** above).

It is proposed to install automatic water level devices (i.e. Eijkelkamp Diver / Solinst Water Level Logger) for continuous water level monitoring in these 16 no. piezometers. Data logged by the automatic loggers should be downloaded every 6 months. In addition to the continuous water level monitoring, the water level in the piezometers will be manually recorded at 6-month intervals for the duration of the monitoring plan.

All 16 no. piezometers will be instrumented at the beginning of the Pre-Construction Phase and monitoring will continue during the Construction and Operation Phases. During the Operation Phase (i.e. post works) all piezometers will be monitored using automatic loggers for the first year. Upon review of the data at the end of Operation Phase Year 1, the number of piezometers being monitored could be reduced if it is deemed that the data is not of significant importance or value.

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Figure G: Groundwater Level Monitoring

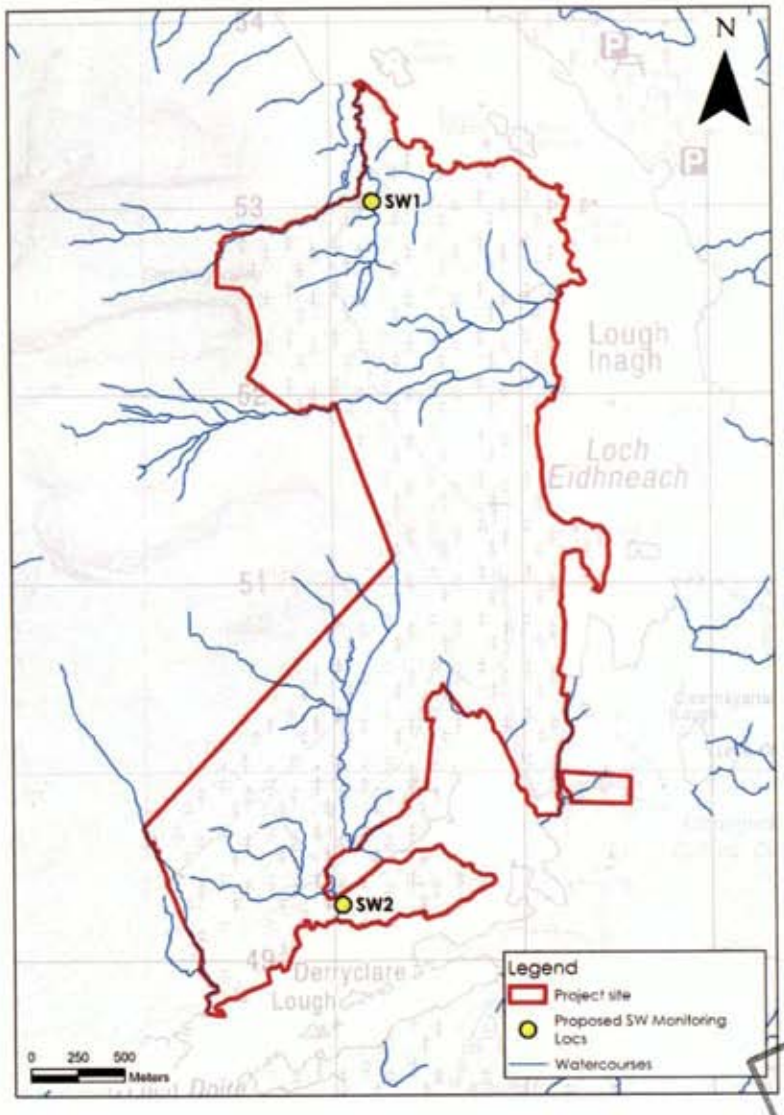

Figure H: Proposed Flow Monitoring Locations

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4.3 MONITORING PLAN SUMMARY

Refer to Error! Reference source not found. below for details.

4.4 REPORTING

Subject to planning approval, Coillte will begin the pre-construction hydrological monitoring which will continue for a period of 12 months prior to the onset of restoration works. Following the establishment of the hydrological monitoring network, monitoring reports and subsequent trend analysis reports will be completed on a biannual basis.

The biannual report will include the presentation of water level hydrographs for the piezometers and the monitored streams and a discussion/analysis of the surface water hydrochemistry data. The trend analysis will determine if there is any significant quarterly variation in water levels or hydrochemistry that requires action/investigation.

The monitoring reports will be shared with all Stakeholders and the NPWS.

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Table A: Proposed Monitoring Plan Summary

Monitoring Location	Easting (ITM)	Northing (ITM)	Parameter	Auto/Manual	Monitoring Frequency	Data Download Frequency
Pre-Works Monitoring (Establishing the Baseline)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Auto – sampler/grab samples	Monthly	N/A
			Flow	Auto – flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	Biannual
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See **Figure B** above		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See **Figure B** above		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Existing Piezometers	See **Figure C** above		Water level	Auto – logger Manual – dip piezo	Continuous (2-hour intervals) Biannual dips	Biannual
Construction Phase (During Works)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
				Manual – grab sampling[1]	1 pre-works, on a weekly basis during works Turbidity event – daily samples until turbidity returns to baseline	N/A
			Phosphorus	Manual – grab sampling	Monthly	N/A
				Auto – sampler	1-week	Weekly

[1] Construction Phase Only

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				Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
				Manual – grab sampling	1 pre-works, on a weekly basis during works Turbidity event – daily samples until turbidity returns to baseline	N/A
			Phosphorus	Manual – grab sampling	Monthly	N/A
				Auto – sampler	1-week	Weekly
				Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See Figure B above		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See Figure B above		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Additional Auto Sampling Locations	Downstream of works area		Turbidity / Temperature / Conductivity	Auto - probe	Continuous (15-minute intervals)	Weekly
Additional Grab Sample Locations	Downstream of works areas		Range of parameters including turbidity and phosphorus	Manual - grab sampling	1 no. sample before felling 1 no. sample during felling 1 no. sample post felling	N/A
Existing Piezometers	See **Figure C** above		Water level	Auto – logger Manual – dip piezo	Continuous (2-hour intervals) Biannual	Biannual
Post-Works (Determining the success of the Project)						
SW1	483201	75304	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	N/A

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			Flow	Auto –flume/logger	Continuous (15-minute intervals)	Biannual
				Manual – flow meter	Biannual	Biannual
SW2	483019	749322	Temperature	Auto – probe	Continuous (15-minute intervals)	Biannual
			Conductivity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Turbidity	Auto – probe	Continuous (15-minute intervals)	Biannual
			Phosphorus	Manual – grab sampling	Monthly	N/A
			Flow	Auto – flume/logger Manual – flow meter	Continuous (15-minute intervals) Biannual	Biannual
P1 – P5	See Figure B above		21 no. parameters	Manual - grab samples	Monthly	N/A
DB2 – DB4 and DB-6	See Figure B above		Aquatic invertebrate communities	Manual – kick sampling	Annual	N/A
Existing Piezometers	See **Figure C** above		Peat Water level	Auto – datalogger Manual – dip piezo	Continuous (2-hour intervals) Biannual	Biannual

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5. MONITORING PLAN SUMMARY

A hydrological monitoring plan has been proposed for the Derryclare Wild Western Peatlands Project.

The overall aim of the monitoring plan is to determine the hydrological success of the restoration project. This will be achieved by monitoring several key hydrological parameters pre- and post-construction.

- The key hydrological parameters generally used to characterise the success of a peatland restoration project are surface water flow volumes and the elevation of the peat water table relative to ground level.
- The plan includes the monitoring of groundwater levels, surface water hydrochemistry and flow volumes at appropriate and accessible monitoring locations within the project site;
- The groundwater level monitoring plan utilises the existing piezometer network at the project site, with groundwater levels being continuously recorded by dataloggers and downloaded at 6-month intervals.
- Surface water hydrochemistry and flow volumes will be recorded at 2 no. locations downstream of the proposed restoration works. It is proposed to complete the monitoring through the use of surface water quality probes and auto-samplers.
- Coillte have committed to completing the proposed hydrological monitoring for a period of 12 months pre-construction and for a period of 3-5 years post-construction.
- The pre-construction monitoring will help establish the baseline hydrological characteristics of the Derryclare Site.
- The operation phase monitoring data will be compared to this baseline data and any deviation from the baseline will be used to determine the overall success of the restoration project.
- In addition, intensive water quality monitoring will be completed throughout the construction phase. This water quality monitoring will concentrate on key parameters including turbidity and phosphorus and will be carried out in accordance with the CEMP.
- All data will be downloaded every 6-months and annual monitoring reports and trend analysis will be shared with all stakeholders and the NPWS.

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Appendix I:

Biological and Chemical Monitoring of Surface Waters:

Derryclare & Cappaghoosh

(Mayfly Ecology 2023)

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APPENDIX 6

FOREST TO BOG BEST PRACTICE OPERATIONAL GUIDELINES FOR BLANKET BOG RESTORATION IN IRELAND

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Draft

Forest to bog

Best practice operational guidelines for blanket bog restoration in Ireland

This document has reviewed the available best practice guidelines for blanket bog restoration applicable to Irish conditions and collated the results into a technical report that can be used for operational planning for Forest to bog restoration projects in Ireland. This is intended to be a working document that will incorporate all applicable future best working practice and developments.

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Author: D Tiernan

Date: May 2023

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Quick links and video gallery

Video gallery

Useful videos from NatureScot: Peatland Action - YouTube

Peat dams: NatureScot Peatland ACTION - Video 1 Ditch Blocking - YouTube

Plastic dams: NatureScot Peatland ACTION - Video 1 Ditch Blocking - YouTube

Timber or composite (mixed materials) dams: Peat Bog Restoration in Scotland - YouTube

Wave dams and Zipping: Peatland Restoration – Wave Damming and Zippering - Technique Guide - YouTube

Surface smoothing: Surface smoothing

Stump flipping: Stump flipping

Forest to bog explained: Forest to bog process

Suite of videos on the different bog restoration techniques: Bog restoration techniques - Nature Scot

Quick links

Peat dams: NPWS peat dams on raised bogs - see page 55

Plastic dams: NPWS plastic dams on raised bogs - see page 58

Leaky dams: NPWS how to construct a plastic leaky dam - see page 63

Reprofiling of interceptor drains:NPWS complete infilling of drains - see page 61

Infilling of drains: NPWS complete infilling of drains - see page 61

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Notes on terminology used.

Artificial drainage pattern: This refers to the forestry drainage resulting from the ground cultivation used to afforest the site. Typically, this is double or single mould board ploughing.

EPA streams:

'Forest to bog' restoration: This refers to the practice of converting forested areas on peatlands back to a bogland habitat.

Furrow blocking: This refers to the bog restoration practice of blocking the ploughed furrow, usually with dams, debris or peat.

Ground smoothing: This refers to the bog restoration practice of smoothing out the ploughed ridge furrow profile, which can be achieved by a variety of methods such as cross tracking, smoothing with the excavator bucket and stump flipping.

Relevant watercourses are existing drains and channels that do not appear on the 6-inch ordinance survey map, that may contain flowing water during and immediately after rainfall and flow directly into an EPA stream or lake

Rewetting: A generic term often used to describe the bog restoration practice of raising the water table to favour the restoration of the peatland habitat.

Ridge and furrow pattern: This refers to the ploughed profile that results after ploughing, where a channel (furrow) is scraped onto the bog surface to create an elevated ribbon (ridge).

Silt traps: A standard water protection measure used to capture sediment flows and slow water flows, typically using strategically placed dam(s) using various materials capable of trapping fine sediment.

Stump and root plate mulching

Natural drainage pattern: This refers to the natural drainage pattern that consists of EPA streams (that appear on the 6-inch map) and relevant watercourses (that do not appear on the 6 inch map). This is best defined as the drainage pattern of the bog before afforestation.

Introduction.

The principal goal of 'Forest to bog' restoration is to remove the conifer forest cover, raise and stabilise water tables as much as possible, and restore the natural topography of the peat surface. Forested sites typically retain a legacy 'ridge and furrow' pattern, with either single or double ploughed furrows varying from 30cm up to 80 cm depth. The type of restoration technique required will depend on site conditions, including site topography, peat type, hydrology, peat depth, peat slide risk, as well as the tree species present, their age, Yield class, rooting depth, alongside the ability to extract timber and harvesting technique used/considered, and the presence or absence of peat forming vegetation. Peat depths and the ground preparation method used for drainage can often inform the type of peatland community that will be restored and help identify the expected target habitat. In addition, assessing the condition of ploughed ridges and furrows is also important as the more prominent these are then the more intervention will be required to flatten and restore the hydrology and topography of the site.

A full literature review on the current understanding of bog restoration for blanket bogs is presented in Appendix 5. This review provides the context of the information presented in these operational guidelines.

In brief, all Forest to bog operations should include the following main steps.

1. Prepare a detailed strategic plan.
2. Correctly time and schedule the restoration work.
3. Develop a site-specific operational plan.
    - Step 1: Remove the conifer trees.
    - Step 2: Prepare a detailed restoration plan for the felled area.
    - Step 3: Segment the site based on slope and peat slide factors.
    - Step 4: Plan effective buffer zones.
    - Step 5: Specify suitable restoration technique(s).
    - Step 6: Control Invasive species.
    - Step 7: Have a grazing management plan.
    - Step 8: Have a site monitoring plan.
    - Step 9: Have a fire plan.

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1.0 Prepare a detailed strategic plan.

Forest to bog restoration is a complex process that requires careful planning to ensure its success. A detailed strategic restoration plan for each site is essential for Forest to bog restoration and this requires careful evaluation, planning, stakeholder engagement, implementation, monitoring, and long-term management. This operational guideline deals with the implementation steps needed for bog restoration, and as a result, only a summary of the detailed required for a restoration plan is briefly outlined here. A detailed strategic restoration plan can cover a period of up to 10 years and it address the following main items.

1. Site Evaluation: The first step is to evaluate the site to assess its suitability for bog restoration. An example of some of the factors to consider include location, proximity to statutory designated areas, soil type, hydrology, suitability for restoration, vegetation, and the presence of invasive species.

2. Situation Analysis: Based on the site evaluation, conduct a situation analysis to identify the problems and opportunities for bog restoration. This process involves gathering information about the site's history, current condition, and potential risks and threats.

3. Goal Setting: Determine the goals and objectives for the bog restoration. These goals could include improving hydrology, enhancing biodiversity and habitat restoration.

4. Restoration Plan: Develop a detailed bog restoration plan that outlines the specific actions needed to achieve the goals identified in step 3. Central to this is understanding the site hydrology.

5. Stakeholder Engagement: Consult with stakeholders such as landowners, community groups, and government agencies to build support for the restoration project and gain insight into local factors that may affect restoration success.

6. Permitting and Approval: Obtain necessary permits and approvals from regulatory agencies to carry out the restoration activities.

7. Implementation: Implement the restoration plan, following best practices to minimize disturbance to the existing plant and animal communities and ensure successful restoration.

8. Monitoring and Adaptation: Monitor the restored bog over (especially water quality) time to evaluate the success of restoration efforts, identify any issues or threats, and make necessary adjustments to the restoration plan.

9. Long-term Management: Develop a long-term management plan to maintain the restored bog, control invasive species, and ensure that the site continues to meet the restoration goals and objectives.

The above approach suits Irish conditions, where large scale projects can be typically phased over several years. In this approach, sites with good restoration potential are initially selected and a detailed hydrogeological assessment is carried out using a combination of LIDAR and field data collection. This allows for an assessment of the drainage system of the

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site to identify where water is entering and leaving the site and this information is used to develop a plan for managing water levels and protecting water quality. Vegetation mapping is used to identify rare species and the dominant plant species and potential for the future target habitats can be assessed. Plans may or may not include water table monitoring.

2.0: Correctly time and schedule the restoration work.

Most restoration work will occur in sensitive areas and consequently the timing of all work is important. While water protection is often the main concern, depending on the site other additional protections maybe required for site-specific bird, mammals, or rare species on site. These protections will be identified at the planning stage.

For a variety of reasons, restoration measure should ideally occur immediately after the conifer trees have been removed. A felled site that has not been re-wetted can continue to emit carbon for up to ten years after re-wetting. The sooner a site can be rewetted, the sooner it can start to recover and move to a system which releases less carbon to the atmosphere and water courses. While restoration techniques can be prepared prior to felling, for optimum results and the selection of the best technique(s) for the site, sites are best surveyed post felling. Post-felling surveys ensure the site can be fully viewed and an accurate assessment made of the drainage patterns, slopes, flushing and the optimum locations of the water protection measures (silt traps, dams, buffer zones etc.). This survey can also occur before the trees are felled, if accessibility through the forest is good. Regeneration of lodgepole pine seedings and invasive species is a known issue with peatland restoration in Ireland. In Scotland, it was observed that carrying out the restoration work immediately post felling and raising the water table as soon as possible, is an effective way to limit conifer and invasive species regeneration by creating unfavorable condition for seeding germination.

A range of restoration techniques can be used on the same site. The guiding principle should be to achieve the restoration aim with the least amount of peat disturbance as possible. In Scotland this is referred to the "Enough and no more". For example, on a well buffered site that is very wet and flat with poorly grown trees on deep peat, restoration might be achieved with tree removal followed by strategic drain blocking of the artificial drains with peat and machine cross tracking to reprofile the site. In contrast, on another site, on a drier flat site where large trees grew on deep peat, restoration might be achieved with tree removal followed by large undisturbed buffer zone creation with strategic drain blocking of the artificial drains achieved using stump flipping.

Another important consideration in the selection of the restoration technique(s) is to ensure that the post felling restoration works do not impact on the adjoining areas that are scheduled for future felling. To do this it is necessary to identify the hydrological units. While this could be approximated at the planning stage, identifying the hydrological units is best done post felling, when you have full visibility of the site. Careful planning will ensure that any restoration work will not compromise the harvesting of adjacent stands. In the

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Coillte estate, forest properties are typically divided into compartments using 3-5m wide unplanted ride lines. Very often these ride lines will use the existing stream network, and this can be used at the planning stage to schedule felling, using the existing stream network as the divide between planned felling coupes.

3.0 Develop a site-specific operational plan.

Once the planning phase is completed, and the correct timing schedules are in place, the following steps are recommended to implement the blanket bog operational plan. The underlying aim is to select the best site-specific restoration technique that can provide the best restoration results with the least amount of disturbance. This is achieved using the following.

Step 1: Map the drainage patterns (natural, artificial, forest road).

Step 2: Develop a tree removal plan.

Step 3: Develop a restoration plan.

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Step 1: Map the drainage patterns (natural, artificial, forest road).

To understand how a forested site is drained it is important to map a) the natural drainage pattern that occurs from the existing streams, b) the artificially installed forest drainage, and c) the drainage installed on the forest road network. It is recommended that the site drainage pattern should be mapped where possible before the trees are felled, or immediately after the trees the felled. Depending on accessibility through the forest crop, the drainage pattern can be mapped before felling, but generally it is easier to map post felling. A detailed walk-over survey is recommended, to assess the site and collect and map key practical information that will inform the restoration technique(s) to employ.

The natural drainage pattern refers to the existing EPA streams and all relevant watercourses. Typically, EPA streams are well mapped and relevant watercourses are usually not mapped in forested areas in Ireland. A relevant watercourse is any other watercourse that has the potential to act as a pathway for the movement of significant amounts of sediment and/or nutrients from the site to an aquatic zone. Relevant watercourses are existing drains and channels that may contain flowing water during and immediately after rainfall. Note, not every watercourse is a 'relevant watercourse'. For example, a well-vegetated drain or ditch draining a small area of moderately sloping ground may not be a relevant watercourse, as there will be little or no potential for it to carry significant amounts of sediment/nutrients. In peatlands, relevant watercourses often have channels that are well eroded and have cut down to the mineral layer. All EPA streams and relevant watercourses will not be blocked during the restoration process as they represent how the bog drains naturally. The most practical and recommended way to locate these relevant watercourses is to walk the length of all the mapped EPA streams and map the relevant watercourse using a field mapping GPS devise.

The artificial drainage pattern refers to the forest drainage pattern installed to establish the forest, which on the Coillte estate is typically plough and furrows bisected with occasional interceptor drains. Most Forest to bog sites on the Coillte estate will be cultivated using ploughing. However, on a minority of older sites tunnel ploughing might have been used, and on the more recent sites, mounding might be used. Typically, approximately 90% of Forest to bog sites on the Coillte estate will be ploughed and how to map these ploughed sites is discussed here. Ploughed site generally were ploughed up and down the slope, with strategic interceptor drains bisecting these drains at right angles. The interceptor drains are small drains, usually only a foot wide, that were installed just below the plough drains and these drains were placed to run along the contour to slow the water down and effectively drained the site. Most sites have only a few interceptor drains that when strategically placed, effectively become the main channels for water exiting the site. It is recommended to map all the flowing interceptor drains and to map the plough drain direction using an arrow to show the plough drain direction pointing downslope. Combining this information with the natural drainage pattern will show how water leaves the site. The effectiveness of the interceptor drains, and the depths of the ploughed furrows need to be considered when selecting the most suitable restoration technique. For example, if an interceptor drain has a low flow of water and the drain is partially revegetated, then reprofiling of the entire drain would be effective. However, if the drain is wide and the flow is strong, then damming might be more effective, if the slope allows.

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The forest road drainage typically includes drains on both sides of the forest road that connect to road culverts and feed into the forestry drainage network. These drains should me mapped with special care given to where they connect to the forestry drainage network. A series of strategically placed silt traps and measures to slow the speed of the water should be considered for these drains. Where available, the hydrological sub-catchments should be overlaid on the planning map. These sub-catchments are the hydrological units specific to the site. (These can be provided at the planning stage using LIDAR and DTM [digital terrain data] data).

The mapping of the natural drainage pattern, the artificial drainage pattern and the forest road drainage pattern provide the necessary information to understand how the site is currently draining and this can then be used to decide the best restoration plan to restore the site. This mapping is most effective when it is done using a field mapping GPS devise.

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Step 2: Develop a tree removal plan.

In general, it is always preferable to remove as much timber and brash (including brash mats) from a site prior to restoration. Water tables are lowered in areas where conifers are planted due to the drainage network present as well as the interception and increased rates of evapotranspiration (Irish Wildlife Manuals No. 99. 2017). Removal of woody material makes subsequent restoration activities easier. If trees cannot be removed, then the next preferable option is to fell to waste and the least favourable option is to mulch the trees and stumps. Typically, a combination of methods will be employed on the same site, owing to the variability of tree growth typically found on these sites. Tree removal on bog restoration sites will occur using 3 main harvesting methods, namely:

1. Conventional harvesting machines/excavator with shears head – extract timber.
2. Conventional harvesting machines/excavator with shears head – fell to waste.
3. Excavator fitted with a mulcher/manual – fell to waste.

All machines used in tree removal will have to have suitable ground pressures (see appendix 1: Understanding ground pressures).

Conventional harvesting machines (harvester and forwarder combination) are expected to be used where there is harvestable material available. This is the preferred option as it ensures that most of the woody vegetation is removed from the site and machines that are purpose built for operating in challenging forestry conditions are used. Conventional harvesting machines typically leave a raised stump, whereas shear heads do not. Where possible, shear heads should be used, as they remove more woody material and make subsequent restoration easier (as there is no raised stump).

The next preferred option for tree removal is felling to waste, either manually or with a conventional harvester. This option leaves the felled trees on site. This will typically occur where there is no harvestable material available, but the trees are still large enough to be harvested either manually with chainsaws or with a conventional harvester (or an excavator mounded with a shears head). This option leaves the woody vegetation on site, which must then be windrowed with an excavator, before anymore restoration works can commence.

Mulching is typically used when the tree size is too small for a conventional harvester to be used. This will occur in areas where there are no harvestable trees, and the tree size is also too small to be felled to waste. (Mulching can also be used for larger tree sizes, but in these cases felling to waste of conventional harvesting is preferred). Typically, a mulcher attachment is fitted to an excavator and the small trees are mulched down to ground level. Mulching leaves the above ground biomass scattered across the surface. Using an excavator with a mounted mulcher is a safer and more cost-effective operation when compared to the alternative of using chainsaws to complete the task manually.

Stump grinding or stump paring with an excavator mounted with a stump grinder is an untested proposed new method. This is proposed as an alternative to stump flipping. The stump grinder pares the stump and part of the root plate away to allow the site to be subsequently reprofiled without flipping the stump. This is expected to be more suitable to sites with large stumps. Field trials will be needed to evaluate if this option is suitable.

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Step 3: Develop a restoration plan.

Understanding the best restoration option to use to restore the site depends on a variety of site conditions that must be considered collectively. As each site is variable, a detailed consideration is needed to ensure the best restoration option is used. No one factor will determine the best restoration method to adopt. Only when all factors are considered collectively should the restoration option be decided. It is recommended, in a Forest to bog restoration, that the sub-compartment be used as the planning unit when prescribing which restoration option to use. As part of standard forestry practice, forested sites are segmented into sub-compartments, which are homogeneous forest areas, typically containing an even aged crop of the same species. For practical purpose, using the sub-compartment is a useful way to assess all the parameters included in the operational specifications, when deciding on which restoration option to use. A summary of all the restoration options and their corresponding operation specifications are given in Table 8 below.

The planner must always aim to choose the restoration option that will yield the greatest results with the least amount of peat disturbance. The main site conditions recommended to segment a site for restoration works include the following.

a) Buffer zones.
b) Peat slide risk factor.
c) Slope.
d) Peat depth (soil type).
e) Tree species (expected stump size).
f) Cultivation type (furrow depth).
g) Water catchment.
h) Elevation (low or high-level blanket bog).
i) Peat piping and peat cracking

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a) Buffer zones

Buffer zones are essential, and they are a central part of the restoration plan. Once the site drainage pattern is mapped, buffers can be put in place along all EPA streams, relevant watercourses and lakes. The width of the buffer zones will depend on the watercourse and the slope. Recommended buffer widths are given the Table 4 below. Wider buffer zones can be specified where deemed appropriate.

Table 4: Recommended buffer widths for blanket bog restoration.

Watercourse	Gentle slope (< 6°)	Intermediate slope (6-11°)	Steep slope (> 11°)
EPA streams	20	30	40
Relevant watercourses	10	20	20

Having effective buffer zones installed is the first restoration operation to carry out as it is a key requirement for water quality protection. The function of the buffer zones is to provide protection to the watercourses from subsequent restoration operations. This is provided when the buffer zones are effective. When planning the buffer zones, the goal is to ensure that the buffers are made effective before the mechanical restoration activities begin. After tree felling and the removal of brash from the buffer zones, the only operations permitted in the buffer zones are the installation of

silt traps, dams and silt curtains on the plough drains, relevant watercourses, interceptor drains and roadside drains. Effective buffer zones will contain a mixture of strategically placed series of silt traps and dams. Ideally, silt traps should be installed before tree removal begins to afford protection from the harvesting operations. Post felling, a greater number of additional silt traps and dams can be installed (as the site will be more assessable). Generally, dams are not effective over slopes of 6 degrees, and it is recommended that larger buffer zones are used on the steeper sites (Table 4).

Once the width of the buffer zones is decided, the next step is to walk all the buffer zones and identify which drains within the buffer zone are carrying water. The number of these drains will depend on the original ploughing method. In some cases, the plough drains will not be continued right into the water courses and in these cases, an effective buffer is effectively already in place. However, in the cases where plough drains were continued right into the watercourse, it will be necessary to map all these effective drains that are visibly carrying water. A detailed combined damming and silt trap plan will be required for all these drains, to ensure that the buffer is fully effective. If the slope is too steep for effective damming, consider the use of a series of silt traps in combination with methods to slow down the flow rate of the water. Alternatively, install dams further back the drain upstream from the buffer zone, if more suitable locations can be found to install the dams and silt traps.

A detailed description of best practice for all damming techniques is detailed in Appendix 1.

b) Peat slide risk factor

Peat slide risk assessments are detailed and complicated. However, their output is presented in an easy-to-understand numeric value. This value is called a "Factor of safety" (FOS) and it describes the calculated risk of a peat slide occurring. Depending on the calculation and the assumptions made in the peat slide risk assessment, typically, values under 1.3 are deemed to be higher risk, whereas values greater than 1.3 are deemed to be lower risk. This FOS value can be used to ensure that the higher risk restoration activities do not occur in the areas with the higher risk FOS values.

c) Slope

Slope is one of the main determining factors when deciding the best restoration technique(s) to adopt. Slope can be very variable across a site, especially in undulating terrain. Therefore, it is recommended where possible to map the average slope on a sub-compartment basis and use this to inform the decision of which restoration technique(s) to adopt. For example, the installation of dams is preferable when the slope is under 6 degrees, surface smoothing can be effective on both gentle and intermediate slopes and windrowing with an excavator can occur on steep slopes up to the manufacturers specified safe working limit.

Table 5: Typical slope categories.

Slope*	In Degrees	In %
Gentle	0 to 5^0	0 - 10
Intermediate	6 to 11^0	11 - 20
Steep	12 to 17^0	21 - 33
Very steep	18^0 and over	33 and over

*Slope categories based on the Coillte inventory standard.

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d) Peat depths

Peat depth is variable for blanket bogs, but it is a useful parameter to use when prescribing the restoration option to use. For example, shallower peat depths would be more vulnerable to more intensive restoration techniques than deeper peats, which would be expected to be more resilient. Afforestation has occurred on both blanket bogs and heaths (wet and dry) and using peat depths can also help distinguish between these on site. The depth of peat can also be used to indicate opportunities for establishing pioneer woodland, where suitable potential areas expected to correspond to peat depths of <0.25m. Table 5 below provides a general guide on how to use peat depths to inform the restoration technique decision. For practical reasons, it is recommended that an average peat depth be calculated for each sub-compartment, to facilitate interpretation.

e) Tree species (expected stump size).

The sub-compartment information is useful existing information to use as it can allow for the extrapolation of the expected stump size. Using this information, the stump size can be estimated using the table below and segregated into 3 categories, namely small, medium, or large stump sizes.

Table 6: Examples of stump size categories.

Stump size	Diameter of stump
Small	< 15 cm
Medium	15 – 30 cm
Large	> 45 cm

f) Cultivation type (furrow depth).

The forestry cultivation type will determine the furrow depths. In terms of restoration, deep furrow depths lead to uneven water table depths across the site, leading to the situation where the upper plough ribbon is considerably drier that the lower plough drain, often leading to one plant community in the wetter plough furrow and one in the drier plough ribbon. Understanding the cultivation type can help inform whether damming or surface smoothing should be considered. Most Forest to bog restoration sites on the Coillte estate are double mould ploughing.

Table 7: Expected furrow depths based on cultivation type.

Cultivation type	Expected furrow depths
Single mould board ploughing	0.2 m
Double mould board ploughing	0.3 m
Tunnel ploughing*	0 m
Mounding	0.5m
2nd rotation flat planting on 1st rotation ploughed sites	0m to 0.3m

**The tunnel drain (or mole drain) is 0.45m underground, with minimal ground disturbance above ground.*

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g) Water catchment

The water framework directive has provided national catchment and sub-catchments layers. All planned sites should include the sub-catchment to inform the restoration options selected, to ensure the site is planned in line with the hydrology.

h) Elevation (low or high-level blanket bog)

In Ireland, a distinction is made between low and high-level blanket bog using the 150m contour line as the divide. This information is useful (especially when combined with peat depths) to help inform the level of restoration effort to adopt.

i) Peat piping and peat cracking

Water quality in a peatland is complex and it depends upon the way the water moves and how it interacts with the peat itself. Peat piping occurs naturally, but it can also occur because of peat drying out post drainage. Desiccation cracking is also a major initiator of pipe formation in peat soils (Jones, 2004). Since peat is typically 90% water, desiccation can lead to peat piping and lead to increased flow in the macropores. This shrinkage and peat cracks increase water colour (dissolved organic carbon) and triggers erosion. Jones (2004) found that natural soil piping affects water quality in blanket bogs and suggested that it can be an important source of "dirty water", with very marked brown colour especially during the first rains of autumn following a dry summer. It can also lead to increased acidity (low pH) of surface water streams. He also noted that by draining and aerating peaty horizons, piping may encourage release of sulphates and organic acids from the peat. Jones noted that 30% of the UK is covered by soils susceptible to natural piping (including peat), so this important flow path should not be ignored.

Peatland restoration needs to consider the impact of peat piping and peat cracking. By its nature, peat piping, and to a lesser extent peat cracking, is difficult to quantify and often the best way to assess a site is to couple visual inspections with monitoring of DOC levels. Successful Forest to bog restoration will inhibit site drainage, close off the surface peat cracks, and this should be reflected in the monitored DOC levels. Soil piping and cracks can make it hard for dams to form good seals, and as a result, using peat dams as the sole restoration measure contains an inherent risk. In these cases, it is preferable to adopt additional restoration measures such as reprofiling, to lessen the risk and use long term monitoring of DOC levels, to monitor their effectiveness.

In Derryclare, the peat piping and peat cracking concerns will be addressed by a combination of establishing effective buffer zones, peat dams, using appropriate reprofiling techniques and long-term monitoring of DOC levels and a detailed monthly chemical analysis. The site will be monitored for surface cracking post felling and if required, remedial action will be taken at this stage. A site walk over survey has not indicated any obvious surface cracking and the DOC monitoring to date would suggest that peat piping is currently not an issue in Derryclare. The development of a restoration plan must consider all the above factors. It is recommended that the buffer zone be put in place first before the adjacent restoration works are carried out. A detailed description of best practice for all damming techniques and reprofiling techniques is detailed in Appendices 1 and 2 respectively. When deciding which restoration option to adopt, please refer to tables 8 and 9 below. Table 8 is the planners guide to selecting the restoration option to use and table is the operators field guide for use once the restoration plan is decided.

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Table 8: Operational specification for each restoration options based on site conditions.

Recommended operation specifications for each restoration option						
Option number	**21 Restoration options (20 bog restoration, 1 replanting)**	**Slope**	**Peat depth**	**Peat slide risk (FOS)**	**Tree species (stump size)**	**Soil type**
1	Fell to waste manually & block interceptor drains	< 6 degrees	All depths	>=1.0	All species (small stump)	BB/heath
2	Fell to waste manually & fill in interceptor drains	None	All depths	>=1.0	All species (small stump)	BB/heath
3	Fell to waste manually, block interceptor drains, remove brash from the buffers, windrow	< 6 degrees	All depths	>=1.0	All species (small stump)	BB/heath
4	Fell to waste manually, fill in interceptor drains, remove brash from the buffers, windrow	SWL	All depths	>=1.0	All species (small stump)	BB/heath
5	Fell to waste mechanically & block interceptor drains	< 6 degrees	All depths	>=1.3	All species (small stump)	BB/heath
6	Fell to waste mechanically & fill in interceptor drains	SWL	All depths	>=1.3	All species (small stump)	BB/heath
7	Fell to waste mechanically, block interceptor drains, remove brash from the buffers, windrow	< 6 degrees	All depths	>=1.3	All species (small stump)	BB/heath
8	Fell to waste mechanically, fill in interceptor drains, remove brash from the buffers, windrow	SWL	All depths	>=1.3	All species (small stump)	BB/heath
9	Fell to waste mechanically, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator bucket	< 6 degrees	>0.5m	>=1.3	All species (small stump)	BB
10	Fell to waste mechanically, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator bucket	SWL	>0.5m	>=1.3	All species (small stump)	BB
11	Harvest trees & block interceptor drains	< 6 degrees	All depths	>=1.3	All species (small stump)	BB/heath
12	Harvest trees & fill in interceptor drains	SWL	All depths	>=1.3	All species (small stump)	BB/heath
13	Harvest trees, block interceptor drains, remove brash from the buffers, windrow	< 6 degrees	>50cm	>=1.3	All species (small stump)	BB/heath
14	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow	SWL	All depths	>=1.3	All species (small stump)	BB/heath
15	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & bucket	< 6 degrees	>0.5m	>=1.3	All species (small stump)	BB
16	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & bucket	SWL	>0.5m	>=1.3	All species (small stump)	BB

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Table 8 (cont.): Operational specification for each restoration options based on site conditions.

Recommended operation specifications for each restoration option						
Option number	**21 Restoration options (20 bog restoration, 1 replanting)**	**Slope**	**Peat depth**	**Peat slide risk (FOS)**	**Tree species (stump size)**	**Soil type**
17	**Harvest trees, remove brash from buffers, windrow & scrap mound (replanting option)**	SWL	**<0.25m**	>=1.3	All species (small stump)	Heath
18	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & grind stumps	< 6 degrees	>1.0m	>=1.3	All species (small stump)	BB
19	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & grind stumps	SWL	>1.0m	>=1.3	All species (small stump)	BB
20	Harvest trees, block interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & stump flipping	< 6 degrees	>1.0m	>=1.3	All species except large LPS (large stump)	BB
21	Harvest trees, fill in interceptor drains, remove brash from the buffers, windrow, surface smooth with excavator & stump flipping	SWL	>1.0m	>=1.3	All species except large LPS (large stump)	BB

SWL – safe working limit of a machine to operate on a slope. Manufacturers specifications.

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Table 9: Operators field guide to the various bog restoration techniques*.

Individual task	Suitability site conditions
Fell trees	All sites where it is safe for a machine to operate. Fell conventionally, fell to water or mulch.
Windrow felled trees	Steep slopes over 6 degrees where dams are not recommended, sloping sites where it is safe to operate a machine but where other restoration methods are deemed ineffective. On fell to waste sites where brash is likely to impede further restoration works.
Dam interceptor drains	Sites with slopes 6 degrees or less. Use peat if the base of the drain is incised to the mineral. Use peat dams or equivalent if base of the drain is peat. Not effective on slopes over 6 degrees. Observe correct spacing between dams.
Dam plough drain	Sites with slopes 6 degrees or less. Use peat if the base of the drain is incised to the mineral. Use peat dams or equivalent if base of the drain is peat. Not effective on slopes over 6 degrees. Observe correct spacing between dams.
Fill in interceptor drains with peat	All sites where an excavator can work safely.
Fill in plough drains with peat	All sites where an excavator can work safely.
Reprofile the plough drains with an excavator bucket	Best where stumps are small (<15 cm diameter) and the site is wet and the peat more malleable. Considered a better option to damming on sites with slopes between 3 and 6 degrees where the peat is shallow.
Cross track with a wide tracked excavator	Used in conjunction with reprofiling, stump flipping. Will depend on the tracked machine used. Limit where possible to one pass, to minimise compaction.
Stump flipping	Best on Sitka spruce stumps (>15 cm diameter) and smaller lodgepole pine stumps, where the inverted stump is large enough to fill the furrow. Best where the peat depth is deep. Can be applied over a range of slopes but most effective on flat sites.
Scrap mounding	All sites identified as suitable for pioneer native woodland where there is sufficient peat depth available to create a scrap mound. Confine to sites where it is safe for a machine to operate.

** The assumption is made that all necessary water protection measures are in place and effective.*

Brief descriptive notes

1. Fell trees: Conventional clearfelling, felling to waste or whole tree mulching.
2. Windrow felled trees: Conventional windrowing using an excavator.
3. Dam interceptor drains: Construction of dams on the interceptor drains (peat, plastic, other) using recommended standards.
4. Dam plough drain: Construction of dams on the plough drains (peat, plastic, other) using recommended standards.
5. Fill in interceptor drains with peat: Infilling of all of the main interceptor drains with peat using an excavator.
6. Fill in plough furrows with peat: Infilling of all of the main interceptor drains with peat.
7. Reprofile the plough drains: Plough rides are slide into the furrows using the excavator bucket.
8. Cross track: Using the machine weight to cross back and over to level off the site.
9. Flip stumps: Filling the furrow with a flipped stump and driving over it to level it out.
10. Scrap mound: Conventional practice of inverting a mound to create a planning medium (for pioneer woodland only).

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Appendix 1: Best practice techniques for drain blocking.

The aim of drain blocking is to block the artificial drainage created to establish the forest and re-instate a more natural hydrology that will retain more water on the peatland. (The natural drainage pattern [aquatic watercourses and relevant watercourses] are not blocked). Typical forest drainage on peatlands in Ireland involved creating a plough ribbon (furrow and ridge) with regular inceptor drains running at 90 degrees to the plough ribbon, with these inceptor drains feeding the collector drains before reaching the drain outlet point.

Blocking drains is a well-established practice in bog restoration and many different materials have been used in the past. More recently, the favoured material is the peat itself as it works well, is cost effective, and is easy to install. While most artificial drainage patterns can often be easily identified from aerial images, the best time to identify these drains is when the crop is felled. A good rule of thumb for all contractors is the instruction to only begin work once effective buffer zones are in place and then block all artificial drains they come across when working on the site. It is also good practice to block drains first at the top of the site and then working downslope. Optimum results are achieved when drain blocking is done in conjunction with reprofiling.

For all dam types, the most important factor is the spacing between the dams. Recommended spacings are given in Table 1. Dam spacing depends on the slope and flow rates. The steeper the slope the closer dams should be spaced. **The water should back up to the toe of the previous dam**. Dams work best on average slopes of 6^0 or less, but with careful planning they can work on steeper slopes. The water pressure behind the dam needs to be also considered, and therefore more and shallower dams are preferable to fewer tall dams, because the failure of one dam may lead to overwhelming the next dam downstream. The more dams are installed the less the overall risk of failure across the site. Dams work best when there is peat in the base of a drain, so a good seal can be created. Dams that are not keyed in are more likely to fail. If your drain has eroded down to the mineral layer, consider stone dams or reprofiling or blocking the drain at another point where there is peat at the base of the drain.

Table 1: General guide to dam spacing in relation to slope.

Slope (degrees)	*Dam spacing (m)*
1	15
2	7.5
3	5
4	4
5	3

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The main drain blocking techniques to block drains are:

1. Peat dams.
2. Plastic dams.
3. Timber or composite (mixed materials) dams.
4. Wooden, metal or stone dams.
5. Leaky dams.
6. Drain reprofiling.
7. Wave dams (new).
8. Zipping (new).

1. Peat dams

NPWS peat dams on raised bogs - see page 55

NatureScot Peatland ACTION - Video 1 Ditch Blocking - YouTube

Peat dams are best suited to standard forestry drains on deep peats (at least 50cm), which have not incised down to the mineral layer and on slopes less than 6 degrees. It is good practice to install peat dams where drains are at their narrowest. The spacing between these dams is slope dependent (see Table 1). A good rule of thumb to assist contractors with the spacing is to ensure that the water from the upper dam always reaches the toe of the lower dam. The dams themselves must be wide enough to ensure water cannot flow around the edge of the dam. The correct width must consider the effect of the drain on the surrounding peat. Immediately beside the drain the peat will be drained and slightly lower on either side of the drain. To assist contractors in building the dam to the correct width, instruct them to build the dam three times as wide as the drain width. Always engineer the dams assuming peak water flows. Where possible, construct dams with a bit of a longer spur on the downhill side to encourage spreading out flow laterally. The height of the dam should also be slightly higher than the fall line of the drain so that water cannot flow or seep across the top of the dam. Take good care to tamp down the dam with the excavator bucket to make sure it is well consolidated and a good seal forms. To finish off the dam it is recommended to take a vegetated scraw from the adjoining bog surface (not the drain) and place it on top of the dam. The construction if peaty dams is better done mechanically as better seals can be achieved, as opposed to a manually constructed peat dam.

The location and quantity of peats dams is best assessed when the crop is felled, when the site is fully visible. When planning the installation of peat dams, it is also important to know when not to use a peat dam. Do not use a peat dam when the drains are over 1m wide, and the flow rates are high. Do not use peat dams when the peat is shallow (< 50cm), and the bottom of the drain is exposing the mineral layer. Peat dams are not suitable on steep slopes and in areas where there are flashy peak flows. Proceed with caution if the drains are close together and running across the slope (as water may be shed from an upper drain into a lower drain because of the dams).

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Another consideration when constructing peat dams is the tendency of deer/sheep/goats or cattle using the dams as crossing points and damaging them. Wherever possible, reprofile the drain sides to prevent dams being the only crossing points. Alternatively, construct a large number of dams so animals aren't using a few dams as the crossing points, and build the dams high enough so they are more robust.

2. Plastic dams

NPWS plastic dams on raised bogs - see page 58

NatureScot Peatland ACTION - Video 1 Ditch Blocking - YouTube

Plastic dams are best used in areas where peat dams are unsuitable and typically these would be in areas where the slope is over 6 degrees, the drain width is too wide and where the pressure of the water is likely to exceed the shear strength of peat dams. Plastic dams create a good seal when driven into at least 25 centimeters of solid peat or clay. On more porous mineral soils, plastic piling dams may not create a good seal. Similar to peat dams, the width of the dam must extend well into the banks either side of the drain. The same rule of thumb used for the width of peat dams can be used for plastic dams i.e., build the dam three times as wide as the drain width. Heavy rain can undercut the dams, especially if there is poor seal. Logs and brash can be placed in the drain to help relive this pressure. Plastic dams can also be used in conjunction with peat dams to relieve water pressures on the peat dams, by strategically interspersing them with the peat dams. Most plastic dams are installed manually but an excavator can also be used. Larger plastic piling structures have a visual impact and they also degrade over time and so carry a long-term pollution risk. Using plastic piling is also much more expensive than using peat dams, and the cost and time to transport materials on and off site has to be considered.

When planning the installation of plastic dams, it is also important to know when not to install them. Plastic dams are not suitable in drains with high flow rates, in areas where the peat is very shallow or there is no peat in the base and on previously afforested sites where the roots make it very difficult to sink the plastic piling and get a good seal.

When planning the installation of plastic dams, it is also important to know what additional work is needed to ensure they are effective. Wide plastic dams need to reinforced, otherwise they will belly out in the middle under water pressure and collapse. Typically, plastic dams wider than 1.5m need to be reinforced. If the sides and the base are not keyed in properly an inefficient seal results, and the peat shrinks around the same resulting in dam failure.

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3. Timber or composite (mixed materials) dams

Peat Bog Restoration in Scotland - YouTube

Composite dams are made with a combination of different materials such as plastic piling, wood, or other materials and are combined with peat. In special situations, composite dams can also be made using wood and mineral soils. Composite dams are generally installed on drains greater than 1.5 m wide where other methods may sag, burst or form a poor seal. Composite dams can be very effective and are capable of holding back a lot of water.

Further details on composite dams are not provided here as it is not expected that any composite dams will be required in Derryclare.

4. Wooden, stone or metal dams

Wooden, stone and metal dams can be used where peat or plastic dams are unlikely to survive, i.e., drains with high water flows, drains with slopes over 6 degrees, in peat drains with a mineral bottom and in wide drains. Stone dams are used where there is not enough peat depth in the base of the gully to secure wooden dams. Metal dams (iron or steel shuttering) have been used to hold back significant amounts of water in very wide drains. It is expected that only wooden or stone dams will be used in a Forest to bog project.

The drawback of wooden dams is that they have a limited shelf life. The type of wood used dictates how long the structure will last. The shelf life is restricted further when only the recommended untreated wood is used. As with all dams, the width of the dam must be three times the width of the drain. Where these are located if often hampered by the terrain.

Stone dams offer flexibility in damming areas where peat dams are not possible. This would include areas on steep slopes and in drains where undercutting is expected i.e., drains where there is no peat at the bottom of the drain. Typically, stone dams are under 1m in height (to avoid collapse). The stone used in the dam should be about 20 cm in diameter, as smaller rocks are more likely to be washed away by strong water flows. The advantage of stone dams is that they do not need to be keyed in the sides of the drain. The disadvantage of stone dams is that they can be washed away by very high-water flows.

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5. Leaky dams

NPWS how to construct a plastic leaky dam - see page 63

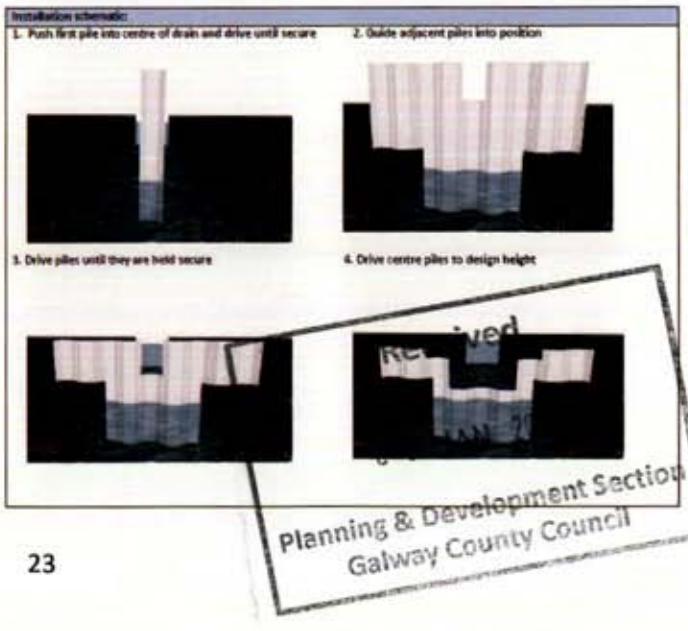
'Leaky dams' refer to partially blocking a drain to keep water levels as high as possible and where the flow is too significant for the channel to be completely blocked. Partially blocking drains is typically undertaken though the use of plastic or wooden dams. Leaky dams are best employed in gullies that are eroded with a lot of bare mineral at the base of the drain. Leaky timber dams are very effective at trapping large amounts of suspended peat, and so are very useful sedimentation control measure.

How to construct a wooden leaky dam

The wooden dams are made from several boards that are allowed to leak so that suspended peat builds up behind the dam and that over time this will be stabilised by vegetation over time. A well-constructed wooden dam will have the lower boards placed close together (to retain water), and the higher boards will have more gaps between them (to allow water to pass through). It is good practice to cut a v-notch in the central splash plate of the dam. Backfilling the downslope face of a timber dam with peat and turf can also be carried out to improve the dams' structural integrity and reduce visual impact.

How to construct a plastic leaky dam

Push the first plastic pile into the centre of the drain, ensuring it remains vertical. Drive the pile into the peat further until it is held firm using a large rubber mallet (if necessary, protect the top of the plastic using a timber batten). Once the centre pile is in a secure position guide adjacent piles into position, pushing into the peat and using the rubber mallet to drive into a firm position. The dam should extend beyond the width of the drain into the bog, typically by a minimum of 50cm to ensure the dam is held firmly. Once all piles have been positioned and are secure they should be driven to a final position, starting from the centre and driving all the piles in the drain down until they reach the design height. Piles towards the outer edge should be driven into the peat until they are secure (remaining approximately 10-20cm above the surface). The plastic piles within the drain should extend at least 50cm below the base of the drain if the peat is very firm. If the peat is weak the plastic should be driven in further until the plastic is held secure.



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6. Reprofiling of interceptor drains

NPWS complete infilling of drains - see page 61

In combination with damming, drain reprofiling is used to further reduce water loss down artificial drains, to remove incised drain features and to reduce erosion of exposed peat on the sides of a drain. It is important to note that the natural drainage pattern of the bog (EPA streams and relevant watercourses) will be left untouched. Therefore, drain reprofiling will only occur on the artificial forestry drainage pattern. This section refers to the reprofiling of the interceptor drains, which were typically installed at 90 degrees to the plough drain as a means of slowing the water and directing it along a preferred drainage pathway. These drains are not part of the natural drainage pattern, and it is recommended that these should be blocked or reprofiled. Drain reprofiling of these interceptor drains should be carried out in conjunction with damming and the use of effective buffer zones at the outlet points.

There are three general techniques:

1. Pushing the edges of the drain into the drain line using the back of the excavator bucket.

2. Re-turving the drain line, which is more like hag reprofiling, when turves are stretched from the drain side into the drain channel, with borrowed turves used from either side of the drain if required.

3. Use of a rollerball.

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7. Wave dams (new)

Watch video on wave dams and zipping (Source Nature Scot)

Peatland Restoration – Wave Damming and Zippering - Technique Guide - YouTube

Wave dams are a new technique that are used for drain sizes less than 1m in width and depth. This was first used in 2014 in Scotland. Wave dams are essentially peat dams constructed at regular intervals constructed from the peat around the drain. This is a quick process, typically 2 minutes per dam, making this cost-effective. They are called wave dams because the regular peat dams along the drain have a wave like pattern in the landscape. This technique applies to long continuous drains that are generally not found in Irish conditions on drained blanket peats.

Wave dams works best on sites that have plenty of bog vegetation and peat available to create the peat dams. The dam width is 3 times the width of the drain. The machine positions itself so that it lines up with the drain and it creates a depression by pulling the bucket towards the machine to create a mound. By reversing the bucket, the mound is squeezed together to compact the mound so that the central mass forms a good seal. The vegetation must not be kept intact on the mound. Tamp down the vegetation on top of the dam and smooth out the sides of the dam using the bucket. Ensure the finished height of the dam is higher than the nearest adjacent ground. Initial form up height should be approximately 30cm above ground level. The whole dam and associated pool will be 1.5 m. It is recommended that wave dams should occur every 4m, or every 8m if done in association with zipping. This job is suited to a 7 – 14 t excavator, on low pressure tracks with a toothed wide bucket

Wave dams work best on deep peat sites, with gently sloping ground and good bog vegetation. Wave dams are not suitable on steep ground (> 12 degrees), when drains are too large, when the peat is too dry and fibrous and when drains have incised down to mineral or bedrock and on ground with poor vegetation cover.

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8. Zipping (new)

Watch video on wave dams and zipping (Source Nature Scot)

Peatland Restoration – Wave Damming and Zippering - Technique Guide - YouTube

Zipping is best used for wide drains (<1.5 m wide). Zipping is a form of re-profiling where the peat dams are constructed at regular intervals (usually every 8m) and the drain completely closed in or "zipped". This form of re-profiling completely in-fills the drain. The combined technique can be used on any site or slope angle that is safe to work with a machine.

To zip a drain, start 1m below the wave dam. Blocks are pivoted across the drain channel from either side of the drain edge in a staggered pattern, inserting the bucket vertically to the full depth, and ensuring the blocks of peat key in behind each other. The voids created by moving these blocks are filled by bulking up peat from behind the first blocks to ensure no voids remain. For this step, only insert the bucket to half its depth. Fill behind the half-depth void behind this infill, move further behind the second blocks and insert just the teeth into the vegetation and roots, and gently stretch the vegetation over the void left by the second blocks. To ensure the blocks of peat are well integrated, tamp down across entire surface of peat that has been moved. If there is a ridge of drain spoil from the original drainage, especially on the downstream facing side of the drain, use the teeth of the bucket to tease the drain spoil ridge apart and then gently tamp down the surface can help to avoid obstacles to water movement. This process is repeated until the next wave dam position is reached. The end result is a zip-like appearance down the drain line. There should be very little sign of the treatment pattern or original drain in the landscape.

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9. Slow water flows (bunds)

Slowing the flow of water is a good strategy to employ where possible. This technique can be used mostly in gullies, and it is also suitable to use artificial drains which have eroded down to mineral layer. There are many different techniques that can be matched to the site, and these include:

Surface bunds can be made out of peat, logs, wood, geo-textile sacks, heather bales, mineral gravel. These bunds slow and break up the flow of water through a gully system and they can catch a lot of sediment. Bunds help alleviate micro-erosion and they reduce the pressure on other downstream restoration measures. (The use of sheep wool may not be suitable as there is a risk of potential contamination of water courses with sheep dip chemicals and straw bales are not very effective as bunds). Bunds work best if placed in a chain formation and the steeper the gradient, the less the distance between the bunds. Generally place bunds 10 m apart, but as well as slope, if the gully is deep (>50 cm deep) then narrow the spacing between the bunds to 7m. Quite often in Forest to bog areas the gully is eroded down to the mineral layer. In this case, using the exposed mineral deposits, build a small mineral bunds across the gully to 30 cm high, place peat on top of mineral bund, then turf over. When installing bunds, start at the top of the system and work down, slowing the flow as you go and remember the bund size is likely to increase as you move down the system.

Surface bunds are not suitable when there is a lot of water moving through the system and when there is very soft sloping ground. Bunds should not be too bog and hold back too much water. Also, be careful with mineral bunds as these will probably eventually wash out. Bunds can very quickly silt up and be over-topped so they will need to be monitored and maintenance will be needed to maintain them in good working order.

10. Stone Dams

Stone dams are very expensive and usually need a helicopter drop. Stone dams are suitable for gullies that are eroded down to the mineral layer, or in areas where the peat is so shallow that timber or peat dams cannot be constructed properly. Stone dams can be a very effective technique that are quick to construct, and they are not prone to erosion or damage, but because of their cost, they are often discounted. Source stone appropriate to the local geology, 15-40 cm in diameter. Use larger cobbles where a leaky dam is required, or smaller stones where the dam is meant to be watertight. Dam spacing is slope dependant ranging from 7-8 m on average and closer for larger slopes. Dams should be no higher than 1 m, the downhill slope of the dam should be 60°and the uphill slope 45°. The dam should be higher at the sides than in the middle (approx. 60 cm). The average dam is 1 unit of 750 kg stone across a gully less than1 m wide. If machine access is possible then re-profile and turf the gully sides and key into the dam. Stone dams can backfill with sediment very quickly, so consider if lots of small, leaky stone dams would be better.

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Appendix 2: Best practice for site reprofiling.

Reprofiling (also known as ground smoothing or surface smoothing) produces an instant surface topography that results in the quickest recovery of peat forming vegetation. Reprofiling removes the ridges and furrows on previously afforested sites to reinstate the topography to what it was before the site was drained. Only the artificial drainage pattern is reprofiled and the existing natural drainage network is left untouched (i.e., relevant watercourses and EPA streams). It is recommended that this technique be used in conjunction with effective buffer zones and peat dams, to protect water quality and ensure that water preferential pathways do not develop along the base and sides of the drains in the future. Vegetation recovery on the resultant smooth surface can be rapid, with good cover of species seen within a matter of 1-5 years. The aim here is to restore the site to as near its original condition before the site was afforested. The walk over site survey post felling will inform the reprofiling decision and match the best reprofiling technique to the site. While this can be approximated at the planning state, it is best done once the site is felled, allowing a trained assessor to make a site-specific informed decision. There is no right or wrong way to reprofile a site. Site reprofiling can involve using a range of reprofiling techniques on the same site. Each site should be treated as unique so that the reprofiling techniques can be matched to the site. Brash mats can be problematic. Ideally you should reprofile under the brash mat, but if the mat is compacted into the ground, then reprofiling under the brash mat should be avoided as it likely to cause too much peat disturbance.

The main reprofiling techniques now employed are as follows.

1. Stump flipping.
2. Reprofiling without stump flipping.
3. Cross-tracking.
4. Reprofiling with stump grinding.

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1. Stump flipping

Stump flipping is a reprofiling technique, which peels off the shallow root systems from the underlying peat, flipping them over, followed by compressing them upside down into the furrows with the back of the bucket. The technique used by the machine operator is important and it involves using a toothed bucket to peel the stump off the peat (to minimizing peat disturbance) and then flip the stump over into the furrow and then by driving over it, the stump is compressed into the furrow. Before stump flipping it is important to set out effective buffers along all watercourses, as a water protection measure. Stump flipping is best used on peats deeper than 1m. Stump flipping is suitable for Sitka spruce crops as they have a shallow root plate, which is least likely to disturb the peat in the catotelm. Conversely, the larger lodgepole pine trees have a deeper root ball, that may bring catotelmic peat to the surface, and for these areas an alternative restoration technique would be more appropriate. Stump flipping can also be done on intermediate slopes. Flipping every stump is not always the best approach, do not flip the large stumps if the expected disturbance is too great, flip all the medium sized stumps and push all the small stumps down into the peat. Aim to retain as much of the surface vegetation as possible, by finding a balance between disturbance from reprofiling and minimal disturbance. All stump flipping should minimize the level of peat disturbance and for the larger stumps and root plates it is advisable to leave these in situ. The machine needed for stump flipping can be either a 14 or 20 t machine, with the larger stumps needing the larger 20 t machine. Underpowered machines will not be unable to flip the stumps (you will observe that the machine will be pulled into the peatland and the stump will not move).

Videos

Peatland ACTION delivery partners are at COP26 (spotlight restoration technique "shears harvesting). - YouTube

Stump flipping

Surface smoothing and stump flipping

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2. Reprofiling without stump flipping – reprofiling with the excavator bucket.

Reprofiling without stump flipping can occur on poorly drained sites where tree growth is very poor, bog vegetation abundant and furrow depths shallow. In these areas, the excavator bucket can be used to level up the site by filling in the plough furrows by either scraping or nudging the ridges into the furrows. Typically, this is followed up by and complimented by cross tracking with the machine to ensure a level surface is achieved and a good deal is formed. This option is limited by the presence of tree stumps and roots, and it is therefore only suitable for the very smaller stumps, but it can also be used in felled areas that are left fallow for a long enough period of time that has allowed the stumps and roots to rot and decay. If reprofiling without stump flipping reprofiling is not possible, then more intense drain blocking of the main and peripheral drains will be required.

If the peat depth is deep, then the felled timber and brash can be used to block the furrows. For this to be effective, peat dams must be installed first. The timber and brash are useful to slow down the speed of the water but they do not form a good seal in the peat. Therefore, this technique will also require peat dams. It is recommended to block all outflows from existing furrows and install silt traps along collector drains and install dams at 10-20 m intervals along furrows and drains (flat ground or shallow slopes <1 degree) and increase frequency on steeper gradients. Dams should be built to plough ridge height (or approximately 20 cm about the round surface if ridges are absent) and staggered between adjacent furrows to encourage rewetting over a wider area. Plastic piling should only be considered if there is no other option as it is more difficult to get a good seal with plastic piling when there are roots in the peat adjacent to the furrow.

Video

NPWS complete infilling of drains - see page 61

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3. Cross-tracking.

Cross-tracking involves an excavator driving back and forth over the ground so that the whole surface gets flattened, any mulch or brash is distributed, and any stumps or woody debris do not spring back up. This method tends to only be used as a secondary technique on sites where previous efforts have failed to completely remove the ridges and furrows. Newer harvesting techniques with machines with wide tracks render it unnecessary. The recommended cross-tracking technique is to initially pass up and down the slope followed by a second pass across the slope. Cross tracking with conventional tracks is not recommended, as it leads to peat compaction. Instead, wide tracked machines (1.5 m to 1.9 m wide) are the preferred option.

4. Reprofiling with stump grinding (new).

Reprofiling with stump grinding is a new approach that involves grinding the stump first to make subsequent reprofiling with the excavator bucket easier. This approach is the same reprofiling without stump flipping as described above, with the addition of first using a stump grinder to grind all the larger stumps. This approach requires two passes with excavators. The first pass is with an excavator mounted with a stump grinder attached to grind the larger stumps. The second pass (it can be same machine with the stump grinder attachment replaced with a bucket) is with the excavator with a bucket attached.

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Appendix 3: A brief note on ploughing

Ploughing was the main cultivation technique used to establish the majority of existing first rotation forestry on peatlands in Ireland and it is these sites that the majority of blanket bog restoration is expected to occur on the Coillte estate. Large scale forestry developments in Ireland started in the late 1950s with ploughing as the cultivation method. It fell out of favour because it presented problems for access for thinning and led to instability as roots were often confined to the plough ribbons. The dominant type was mould board ploughing (single and double mould board). Tunnel ploughing (or mole ploughing) was also used but it was found to be unsatisfactory on peats (where the tunnels collapsed and did not aid in draining the land) and was eventually phased out. Figure 1 below shows the typical method used to plough a site.

- Ploughs were mounted on bull dozers and straight plough lines were typically ploughed up and down the slope.
- The ploughs produced a ridge (or ribbon) and furrow (or plough drain) network.
- Inceptor (or collector) drains were often placed along the contour at 90 degrees to the plough direction (to slow the water down) and these were often channelled along a preferential flow path to the exit point at the watercourse.
- Very often the plough ridge (or ribbon) led directly into the watercourse or stopped just short, leaving a buffer zone or overland flow area.
- The plough ridge (or plough ribbon) was planted with trees usually at 1.7m to 2.0m spacing.
- Most plough furrows do not carry continuous flowing water with the majority of furrows only carrying overland flow. Their effectiveness was to dry out the immediately surrounding peat to allow enough aerobic conditions for the tree to survive.
- Overtime the plough furrow becomes overgrown and often the only furrows with flowing water are the ones where the preferential flow path exists.
- Typical furrow for ploughing depths were 0.2 and 0.3m for single and double mould board ploughing respectively.
- Tunnel ploughing (or mole ploughing) were typically to a depth of 0.45m and for the mole drains to be effective it was necessary to install collector drains that were deeper than the mole drain. Mole drains worked best on flat sites and were not suitable for peat sites, as the mole drains were prone to collapsing.

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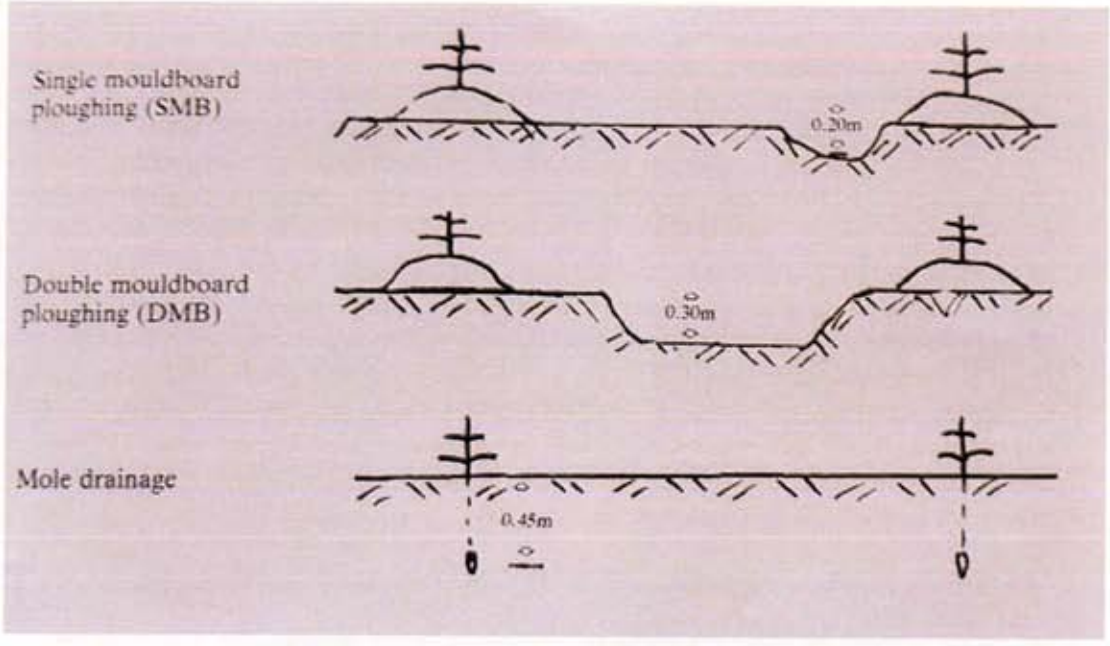

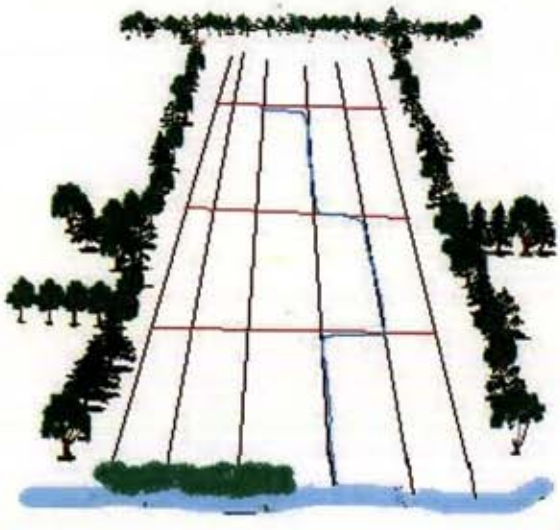

Plough furrows
Inteceptor drains
Preferential flowpath
Buffer zone
Watercourse

Appendix 3 figure 1: Schematic overview of main ploughing techniques used historically for forestry on peatlands in Ireland.

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Pictures gallery of forestry ploughing

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Appendix 4: Understanding machine ground pressures.

The context

Forest to bog restoration requires the use of low ground pressure machines. Typically, 14-ton and 20-ton excavators are used and to work these sites safely, these machines need to be modified by fitting wide tracks. The determining factor is the nominal ground pressure of the modified machine. This note provides the relevant details necessary to understand this approach. Increasing the size of the contact area on the ground (the footprint) in relation to the weight decreases the ground pressure. Ground pressure of 14 k/Pa (2 psi) or less is recommended for traversing very soft terrain like bogs.

Definition

Ground Pressure (or nominal ground pressure, NGP) for machines is basically their weight divided by the ground contact area.

How to calculate it

Nominal Ground Pressure (NGP) = Weight (in Kg) / Contact area (meters),

SI units (Metres, and Kilograms) so that the NGP is in kilopascals (k/Pa)

Example 1

14-ton excavator with standard tracks (0.7m x 2.3m) with a contact area of 3.2 m^2

14,000 kg / 3.2 m^2 = 4375 kg/m^2

Convert to kPa by multiplying by 0.00980665 = 42.9 kPa

Example 2

14-ton excavator with 1.9m wide tracks (1.9m x 3.5m) with a contact area of 13.3 m^2

14,000 kg / 13.3 m^2 = 1052.6 kg/m^2

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Main points to note...

1. The machine weight in the manufacturer's specification sheets are not always correct. Machine manufacturers often promote their machine as 'forest friendly' without reference to how these were calculated. Therefore, manufacturer figures related to a machines Ground Pressures should be used with caution.
2. Where possible, verify the ground pressures on site.
3. When measuring remember that:
    a) Effective comparisons must assume .
        - Equal weight distribution on both tracks.
        - All calculations are based on the horizontal surface.
    b) Ground pressure can change in the following circumstances.
        - When operating on a slope (weight transfers).
        - When tracking (tractive effort).
        - If track 'wings' are fitted.
    c) In Coillte, our NGP is typically measured on actual contact areas (sinkage is ignored).
4. There are practical implications to consider when fitting wider tracks to a machine and these are:
    - Modifying an undercarriage to have a low ground pressure is costly.
    - Fitting 1.9m wide tracks cannot be done on existing undercarriage without significant costly machine modifications.
    - General industry practice is to have specially engineered undercarriages with the wide tracks and the excavator is then mounted on top.
    - Certain excavators can be moved onto different undercarriages with 'minimal engineering' effort. Undercarriages can be interchanged to most excavator brands:
        - Generally, the hydraulics are interchangeable.
        - Slew ring bearings may differ but this can be corrected using a custom-made adapter.
        - Custom grease plates maybe needed but these are generally inexpensive.
    - Provisional rough cost (over the phone) from Ryan Engineering is 100k and 130k per for 1.9m and 2.2m wide fitted undercarriages with pads.

Appendix 5: Literature Review.

Best practice blanket bog restoration

Literature review

Author: *D Tiernan*

Date: *June 2023*

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1.0 Introduction

This paper reviews the best current understanding for the main parameters affecting peatland management with particular emphasis on understanding the dynamic associated with peatland restoration on blanket bogs and in particular the restoration of afforested peatlands, more commonly known as 'Forest to bog'. Many countries are now developing national peatland strategies to promote their restoration and ensure their continued existence and functionality into the future. In general, the consensus today is that peatland restoration should be attempted where it is feasible. This review looks at some of the main questions that need to be considered when attempting Forest to bog peatland habitat restoration projects.

According to the IPPC (2021), the peatland cover in the Republic of Ireland is in position 3 in the world, with peatland covering 17.2% of our land area. Coillte is the largest single owner of peatland in the Republic of Ireland. The total peatland area under its management is 232,509 ha. The Conservation Status of Irelands peatland habitats is described by the NPWS as largely "Bad and Deteriorating". Wise use of peatlands is essential in order to ensure that sufficient areas of peatlands remain on this planet to carry out their vital natural resource functions while satisfying the essential requirements of present and future human generations. According to Joosten et. Al (2002) the European experience shows clearly that an abundance of mires (bogs) is no guarantee of their long-term survival. For example, Finland has lost 60% of its formerly extensive mire area, largely by drainage for forestry since the 1950s. The mires of Polesia in Belarus and Ukraine, one of the largest continuous mire areas of the former Soviet Union have largely been drained in the 1970s and 1980s. Ireland, where bogs originally covered 17% of the country, has lost 93% of its raised bog and 82% of its blanket bog resource (Foss, 1998). With such a large area of bogs lost, availing of restoration opportunities where possible becomes even more important.

Coillte as the largest single owner of peatland in Ireland and is ideally placed to play key role in bog restoration (IPCC, 2021). Table 1 below shows that forested peatland accounts for the largest land use type and restoration in this area will potentially have the greatest impact. To date Coillte have engaged in various bog restoration projects on both raised and blanket bogs. The Western Peatland Project aims to abide by Principle P24 of the National Peatland Strategy which states that "Coillte as the managers of significant tracts of peatlands on behalf of the Irish people will continue to show leadership in responsible management, rehabilitation and restoration of peatlands".

Table 1: Land use of Ireland's peatlands

Land use on national peatlands	National peatlands (%)
Forested	28%
Turbary/private turf cutting	27%
Reclaimed for agriculture	6%
Peat energy	6%
Overgrazed	5%
Milled for horticultural moss peat	2%
Relatively intact but under pressure	25%

Source: Irish Peatland Conservation Council, 2021.

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Coillte Nature (https://www.coillte.ie/coillte-nature/coilltenature) is the not-for-profit branch of Coillte that is dedicated to the restoration, regeneration and rehabilitation of nature across Ireland. Our mission is to deliver real impact on the climate and biodiversity crises through large-scale projects based on the best ecological evidence. We are building on 30 years' experience in forestry, land management and habitat restoration to deliver real impact on the climate and biodiversity crises through innovative projects-of-scale across including planting new native woodlands on un-forested land, restoring important biodiversity areas by investing in major habitat improvements, regenerating urban forests for the benefit of people and nature and rehabilitating ecosystem services by bringing sensitive or degraded lands into better health. Our approach is underpinned by principles of partnership, integrity and accountability, informed by the best ecological evidence, and supported through collaboration and engagement with public, private, non-governmental and community partners. The Wild Western Peatlands (WWP) project is a Coillte Nature project that looks to rehabilitate blanket bog ecosystems. It is a 2,100ha project that is publicly funded by DAFM to serve as a template for future large-scale Forest to bog projects. Coillte's new strategic vision for forestry has identified 30,000 hectares of peatland forests that could be redesigned by 2050 through a programme of rewetting or rewilding. Coillte Nature is working closely with NatureScot in Scotland, who are leading the way in Forest to bog restoration projects at scale.

This report is prepared to inform readers of the main factors associated with blanket bog restoration and serves to inform and educate. Where possible references are made to scientific papers and on-line tutorial videos. The author's concluding remarks are given at the end.

The main factors discussed are as follows.

1. Blanket bogs – the basics.
2. A brief history of afforested peatlands in Ireland.
3. A review of EU LIFE bog restoration projects to date.
4. Effects of forestry on peatlands in Ireland
5. Understanding Peatland hydrology.
6. Why is it urgent to restore afforested peatlands now?
7. Forest to bog restoration in Great Britain, Scotland and Ireland.
8. Author's concluding remarks.

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1.0 Blanket bogs - the basics

Blanket bog formation

Blanket Bog formed when the climate changed 10,000 years ago to wetter conditions and/or the action of man felling forests resulting in watertight iron pans in their upper horizons and consequently waterlogged soils triggering the process for blanket peat formation to begin (Lindsay, 2010). Active peat forming bog refers to a peatland habitat that supports a significant area of peat-forming vegetation where the right conditions prevail for active peat accumulation to occur. Peat in its natural state is composed of 90% water and 10% solid material. It consists of Sphagnum moss along with the roots, leaves, flowers and seeds of heathers, grasses and sedges. Occasionally the trunks and roots of trees such as Scots pine, oak, birch and yew are also present in the peat. Active peat forming blanket bog is defined as peatland supporting significant areas of vegetation that are normally peat forming (e.g. Schoenus nigricans, Molinia caerulea, Eriophorum species and Sphagnum species). Plant communities and microtopography of "active" or peat-forming blanket bog can be very variable. Due to centuries of use and continued degradation, only 20-30% of blanket bogs are regarded as active (Regan 2020), with the remained described by the NPWS as "Bad and Deteriorating" (IPCC, 2021).

Blanket bogs and carbon

Carbon is taken in by peatland plants through the process of photosynthesis from CO2, largely from the atmosphere. Actively growing peatlands accumulate organic mass, and thereby sequester C as the accumulation of organic mass is greater than the extent of vegetation decay. Peatlands has some vegetation decay and this releases C, but the accumulation process is greater, resulting in the peatland becoming a C sink (Joosten et al.,2002). Most of the vegetation decay takes place aerobically in the surface horizons (the acrotelm). However, anaerobic decay also continues, albeit at a much slower rate, at depth in cold, anaerobic horizons (the catotelm), releasing methane. When peat is wet the carbon stocks are safe and carbon sequestration may be occurring. When peat is drying, the carbon stock is being lost as well as the capacity of the peatland to sequester carbon.

Forest to bog

Forest to bog is term used to describe the removing of a forest on a peatland to restore it to its original bogland habitat. According to Campbell et all (2019) the challenge of restoring blanket bog from forestry requires different approaches to those generally used for open peatland restoration. Restoration projects must reverse the impact of the ridge-furrow cultivation process which continues to persist post-felling, as well as raising the bog water table within the underlying peat mass, which have been damaged by the afforestation process. Methods comprising various surface smoothing techniques, and furrow/drain blocking or a combination of both have shown good potential in restoring the blanket bog habitat. Mitigation measures to manage surface runoff (particularly water quality) are required. The timescale for specialist bog plants to fully recolonise following treatment - and for bare peat to be re-colonised is likely to be 3-10 years. Conifer regeneration can be dealt with by surface smoothing methods, but otherwise must be removed by additional treatment depending on size and density (Campbell et al., 2019).

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2.0 A brief history of afforested peatlands in Ireland

The bulk of afforestation of western peatlands in Ireland occurred between the early 1960's to the late 1980's, with a single objective of timber production (Farrell, 1997). At the time, the suitability of certain peatland areas for sustainable forestry was secondary to the more urgent short-term requirement to provide employment in disadvantaged rural areas (Tiernan, 2004). Today, public support for afforestation on western peats has declined (Renou and Farrell, 2005). As a result, afforestation on peatlands is no longer grant aided by the Forest Service, and this effectively has curtailed further afforestation on western peatlands for well over a decade. In 2012 the Forest Service moved away from grant aiding forestry on blanket peatlands, based mainly on environmental and economic concerns. The Forest Schemes manual requires that "The land must be capable of producing yield class 4 for oak or beech or at least yield class 14 for Sitka spruce using normal forestry practices". (Forestry Schemes Manual, Section 6.2.). This economic threshold for forestry on peatland is often not met and in 2012 the Forest Service no longer grant aided new forestry developed on 'unenclosed land', which is typically almost exclusively associated with blanket peat soils. However, the main driver behind this decision was the environmental sensitivities associated with forestry on peatlands in general. In terms of peatland restoration, the forest industry has responded appropriately by preventing future afforestation on peatlands, but the legacy of afforested sites remains, and the challenge ahead is how best to manage these going forward.

3.0 A review of EU LIFE bog restoration projects to date

The importance of bog restoration was recognised by the EU and resulted in significant LIFE funding for bog restoration projects across the EU. A detailed review of all LIFE funded projects between 1993 and 2015 was conducted by Anderson et al., (no date) and this review provided valuable insights for future restoration projects. The EU-LIFE nature programme alone invested €167.6M in 80 peatland restoration projects and these included 1) 319 projects on Raised bogs, mires and fens", 2) 80 projects on improving peatland habitats, 3) Restoration of extracted peatlands, 4) restoration of damaged raised and blanket bogs, 5) Restoration of isolated and remnant peatlands (Belgium, Switzerland, Spain), 6) Restoration of mountain peatlands, 7) Restoration of afforested peatlands, 8) Restoration of eroded peatlands. Anderson advocated that while peatland restoration should be attempted wherever it is feasible, not every site is suitable for restoration and that the level of peatland derogation will determine its ability to recover. Post restoration recovery can be slow and can take up to 10 years on some sites (Carroll et al. 2009). Anderson also observed that monitoring of LIFE sites was limited to the sites under restoration (i.e., no reference sites) and not comprehensive enough for statistical analyses, making a general conclusion about the "success" of the programme's investment impossible to reach. Published evidence of restoration progress for LIFE sites is limited and generally lacks both baseline measurements and robust standardised monitoring schemes. The prohibitive cost of monitoring was cited as the main (and acceptable) reason for not doing the comprehensive monitoring. Consequently, Anderson concluded that in the absence of comprehensive monitoring, selecting the best sites for restoration becomes critical and an evidence-based priority setting with clear guidelines needs to be in place. Anderson

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observed that across the EU, many forestry plantations on peatlands are now coming to the end of their first rotation and the issue of re-stocking these sites must be addressed. To assist this, it is recommended that an evidence-based approach be taken to enable a rigorous assessment of which sites are best suited for re-stocking and which ones for restoration.

This review highlights that it is difficult to measure the success of bog restoration projects and that the level of monitoring needed for statistical comparisons can be prohibitive. Consequently, the most important decision is to select the best sites for restoration and ensure that a robust assessment is made to determine its suitability for restoration. Adopting an evidence-based approach will ensure that only suitable sites are selected for restoration.

4.0 Effects of forestry on peatlands in Ireland

Most afforested peatlands in Ireland were drained using single and double mould board ploughing and to a lesser extent tunnel ploughing. Tunnel ploughing involved creating a small tunnel under the surface to facilitate drainage. This method was deemed unsuitable as the tunnels were prone to collapsing and this method was discontinued. Most afforested peatlands were drained using mould board ploughing, which scraped the surface of the bog to create a plough furrow drainage pattern. Forest drainage typically facilitated drainage and drying out of upper layers of the acrotelm and left the catotelm relatively unaffected (except maybe at drain edges). It was generally observed that these forestry drains were only effective adjacent to the drain and that the sites remained wet (Labadz et al., 2010). The successfully establishment of forestry on these sites also required a tree species that can tolerate wet conditions (lodgepole pine) and additional fertiliser inputs.

According to Lindsay (2010) drainage impacts on peats in 3 ways. 1) Primary consolidation occurs. Shrinkage of the peat adjacent to the drain occurs, especially where the plough furrows are deep. 2) Secondary compression of the peat occurs. This is the phenonium when drained peats drain the 'free' (or interstitial) water from the peat and this removes the floating effect. The catotelm peat adjacent to the drains becomes a heavy load on the peat and this load compresses the peat beneath it and squeezes more water from the peat into the drain, causing the bog surface to subside. 3) Oxidative wastage occurs. Deep drainage allows oxygen to penetrate the catotelm. Once oxygen penetrates the catotelm peat store, relatively rapid decomposition can take place. As the trees grow, their roots suck water from the peat and the canopy will prevent rainfall reaching the bog surface, while the weight of the trees further compresses the peat (Armstrong, et al., 2010); (Wallage, et al., 2006). Drainage can increase DOC production. Drainage modifies the peat structure and hydrological flow pathways, and, depending on topography, runoff can become increasingly flashy, even though lower water tables restrict overland flow (Holden, et al., 2006). The loss of peat forming species may cause leaching of acidity, metals and nitrates into watercourses with subsequent impacts on water quality aquatic ecosystem condition. Typically, afforested western peatlands in Ireland are a damaged haplotelmic bog (a single-layered bog). It may still have vegetation cover, but this vegetation is not adding fresh peat because it is not a

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wetland vegetation and is more likely to be causing further degradation of the peat through the aerating and drying action of its root systems.

There are three other pressures typically associated with afforested peatlands in Ireland and these will also apply to any restoration effort and these are pressures from grazing, invasive species and fires. Grazing pressures from mainly sheep and deer can lead to dominance by Molinia caerulea and Eriophorum vaginatum (Shaw & Wheeler, 1994) with a decline in Sphagnum species (Lindsay, 2010). There are many papers on rhododendron control (Higgins, (2008) Cross, (1973) Rotherham, (1983). Edwards, (2006)) and it is well understood. Their control is essential and often problematic and success removal requires continual vigilance and many costly interventions. Fires tend to burn only the surface vegetation and drier features such as hummocks but leave much of the wet surface relatively intact. For infrequent fires there is generally sufficient time for the bog surface vegetation to recover, but for more frequent and severe fires, (where the fire burns under the surface) it can take more than 50 years for Sphagnum plants to return when burning has produced a bare peat surface (Maltby, et al., 1990); (Evans & Warburton, 2007).

Habitat loss of peatlands is having a dramatic effect on peatland birds. Many peatland birds are on the amber or red lists as a result of habitat loss. These include Merlin, Meadow Pipit, Red Grouse, Curlew, Snipe, Golden Plover, Skylark, Kestrel, Hen Harrier, Marsh Harrier, Peregrine and Lapwing (Irish Peatland Conservation Council 2021).

5.0 Understanding Peatland hydrology.

Understanding peatland hydrology is key to successful bog restation. Peatland hydrology can be very complicated and site specific. The aim of all bogland restoration is to reinstate the acrotelm with the expectation that it will actively deposit plant material annually to the catotelm. At its core, a sites hydrology essentially depends upon the way the water moves and how it interacts with the peat itself. Raised peat contain many different peat types and often the hydrology in these bogs is more complex than in blanket bogs where there is not the same peat type variation. Water quality in a peatland is influenced by the underlying geology, the number and nature of water sources and the chemical deposition from the atmosphere as well as the characteristics of the vegetation and the peat itself (permeability, presence of 'pipes' etc. (Labadz et al., 2010). Blanket bogs are rain-fed peatlands where most of the water flows either over the surface or close to the surface. The hydraulic conductivity of peatlands is generally very low and can vary between the mm or cm range per day and this range is largely determined by the physical properties of the peat (Labadz et al., 2010). In blanket bogs the physical properties of peat can vary, but typically this variation is not as great as it is for raised bogs. The soil profile in a blanket bog is broadly categorised into two types, namely the "acrotelm" (the upper active layer where the water table fluctuates) and the "catotelm" (the lower layer which remains saturated). This profile is described as "diplotelmic", meaning that it has two layers of soil, an upper active layer of roots and recently decomposing plant called the "acrotelm" and a lower layer of denser and more decomposed (humified) peat called the "catotelm" (Ivanov, 1981). In an active blanket bog, material is added annually to the catotelm by decomposition of plant material from the acrotelm, so that the catotelm becomes deeper and denser over time. As the catotelm gets denser it also reduces the size of the pores which also reduces the hydraulic

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conductivity of the catotelm peat. The low hydraulic conductivities within the catotelm are key to maintaining a high-water table close to the ground surface, a condition which is essential to the continuing functioning of surface bog vegetation (Labadz et al., 2010). Forest drainage and tree growth disturbs this hydrological balance by lowering of the water table, aerating the acrotelm layer and allowing tree growth to occur. In terms of restoration potential, drained peatlands are viewed as disturbed and degraded and are no longer considered as "active" because material from the acrotelm is no longer added annually to the catotelm. Restoration looks to reinstate the acrotelm with the expectation that it will actively deposit plant material annually to the catotelm.

Little of the water received in an intact peatland as rainfall is retained by the bog. Peat has an extremely high-water content and in an intact peatland, most of the water storage capacity is already full. Therefore, contrary popular understanding bogs do not act to delay peak flows into streams. The often-quoted idea of a peatland as a "sponge" that soaks up rainfall and then releases it slowly into rivers is erroneous. The response of an out-flowing stream to rainfall received over a peatland depends upon the path taken by the water and the velocity of the flow it achieves. In a pristine peatland, the water table is likely to be close to the surface almost all the year and rainfall will quickly lead to saturation of the peat, which in turn leads to overland flow. Holden and Burt (2002) performed rainfall simulation experiments on blanket peat and showed that 30-40% of rainfall could appear as surface runoff and another 20-35% would runoff rapidly at a depth of only 5cm, but under vegetation the flow at 10cm depth was much less than 10% of rainfall. Rainfall input produces a rapid stream runoff response in peatlands, especially where the catchment has a dense gully network.

The majority of blanket peatland afforestation in Ireland is on a relatively impermeable underlying geology. In peatland areas where the underlying geology is more freely draining, flushed peats have developed (typically served by a consistent water supply from springs). Darcy's law says water flows through a unit area of wet peat is determined by the combination of hydraulic conductivity of the material and the hydraulic gradient (fall in height over horizontal distance travelled). Bogs remain wet because peat generally has low hydraulic conductivities, retaining water even when there is a relatively high hydraulic gradient. Velocity of flow of water though peat therefore is determined by its hydraulic conductivity. The acrotelm peat is more porous than the catotelm peaty and as a result the acrotelm has a higher hydraulic conductivity than the catotelm. The low hydraulic conductivities within the catotelm help to maintain a water table close to the ground surface, and any disturbance of the catotelm (or acrotelm) hydrology has an impact on surface vegetation.

The water table is critical for peatland development because it controls species composition through anoxia (lack of oxygen) at depth, which retards decomposers and so enables peat accumulation. Studies have found that the water table stayed within 5cm of the ground surface for 83% of the time, with the fall in summer being explained by evaporation losses. The water table is the level at which water pressure in the soil is equal to atmospheric pressure, at which water will stand in a well that is hydraulically connected with the groundwater body (Gilman, 1994). In peats these water tables fluctuate naturally. In general, studies have found that most variation in water table levels occur during the

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summer when the levels fall, possibly due evaporation losses. Evans et al (1999) found that blanket bog water tables remained within 5cm of the ground surface (i.e., within the acrotelm) for over 90% of the time. This is consistent with another study which has shown that for 83% of the time the water table remained within 5cm of the ground surface and fluctuated for 17% of the time (Labadz et al., 2010). This seasonal variation is problematic when monitoring water table levels. Allott et al (2009) have suggested that 15 dipwells is the minimum required for adequate representation of water table fluctuations at a site. However, studies by Labadz et al., (2007) quantified the level of water table fluctuations (Figure 1) and this demonstrated that extent of natural water fluctuations in the water table. In terms of monitoring, this presents a huge challenge to distinguish between natural fluctuations and fluctuations caused by the bog restoration measures. Evans et al (1999) found that blanket bog water tables remained within 5cm of the ground surface (i.e., within the acrotelm) for over 90% of the time, and that high stream flows always occurred at times of high-water table. They concluded that there are 2 important mechanisms for generating rapid flow from blanket peat catchments: 1)saturation-excess overland flow (in areas such as hollows or close to the stream channel, where already saturated peat cannot accept any further input of water from the surface) and 2) rapid acrotelm flow over a saturated catotelm (a lateral flow, often within 5cm of the ground surface, generated by the lower hydraulic conductivity of the deeper peat).

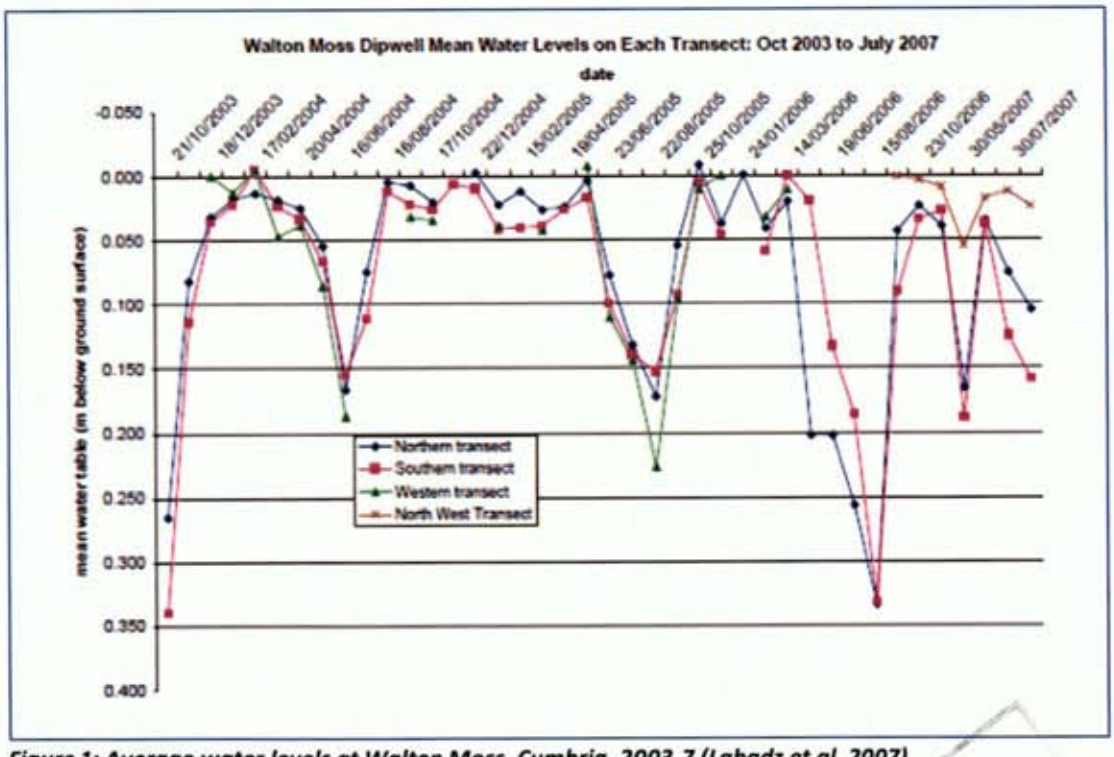

Figure 1: Average water levels at Walton Moss, Cumbria, 2003-7 (Labadz et al, 2007)

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Water quality in a peatland is complex and it depends upon the way the water moves and how it interacts with the peat itself. Influencing factors include the underlying geology, the number and nature of water sources and of chemical deposition from the atmosphere as well as the characteristics of the vegetation and the peat itself (permeability, presence of pipes etc.). Discharge of dissolved organic carbon (DOC) occurs naturally in peat soils, and it is associated with blanket peat catchments and manifests itself as brown discoloration. As expected, DOC concentrations are positively correlated with stream discharge. High levels of DOC in water from peaty catchments come primarily from humic substances, which although not directly harmful are removed from drinking water for aesthetic purpose. Clark et al (2008) stated that peatlands are the greatest source of DOC to natural waters and that most of it is transported during storm (rainfall) events. Adamson et al (2001) found that dissolved organic carbon (DOC) at 10cm depth peaked each summer and was related to temperature. Jones (2004) found that natural soil piping affects water quality in blanket bogs and suggested that it can be an important source of "dirty water", with very marked brown colour especially during the first rains of autumn following a dry summer. It can lead to increased acidity (low pH) of surface water streams. He also noted that by draining and aerating peaty horizons, piping may encourage release of sulphates and organic acids from the peat. The lowering of the water table in dry conditions allows oxygenation of sulphides to sulphate, which is acid and so reduces the solubility and mobility of the carbon, thus DOC concentrations will be lower during droughts and rise again afterwards. Therefore, when water levels are high, bogs can act as substantial sinks for sulphate and reduce DOC mobilisation. Stream DOC is positively related to temperature and is the main factor affecting DOC levels. Gibson et al (2009) concluded that the blocking of drains can decrease the export of DOC, but this decrease was mostly associated with decreasing water yield (flow) rather than reduced concentrations.

Land management influences the vegetation on site which in turn influences the hydrology and water quality. Drainage of blanket bogs has been shown to influence both the properties of the peat and the runoff characteristics of outflowing streams. Ramchunder et al (2009) noted impacts on peat shrinkage and consolidation, microbial activity and decomposition, all influencing hydraulic conductivity and water storage capacity as well as flow rates and processes and susceptibility of the peat to erosion. Historically, the purpose of forestry drainage (using plough ditches) on peats in Ireland was to lower the water table so that the top layer of peat would become aerated enough to facilitate tree growth. Price et al (2003) said the efficacy of drainage depends on the depth of the ditch, the distance between ditches and the hydraulic conductivity of the peat. Water tables might be drawn down up to 50m from the ditch in fibrous peat. Robinson et al (1998) showed in upland peat soils that drainage for forestry initially increased the runoff response of peat areas under wet conditions but can also induce increased storage between storms leading to larger antecedent soil moisture deficits. Some drained blanket peatland catchments have been found to exhibit an increase in low flows and this may be associated with the de-watering of the catchment through the slow drainage and drying out of the normally saturated catotelm (Holden and Burt 2003). Although it is accepted that the lowering of the water table may cause an increase in available storage of water during rainfall events, making the stream runoff response less sensitive in the short-term and as a result water will continue to leave the catchment (Holden et al 2004, Holden, 2006). In the long-term, continuous dewatering of peat potentially creates desiccation and soil instability resulting in an increase in

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subsidence and decomposition, a widening of surface drainage and subsequently an increase in runoff and the return of a flashy response to rainfall events and flood-risk once more (Holden et al 2004, Holden et al 2006). Holden et al (2006) studied five locations in two blanket peat catchments that had been drained with open ditches in the 1950s and found that on the drained catchments the overland flow response was short and sharp, as the ditches efficiently removed runoff and produced an even narrower, more peaked hydrograph than on the intact catchments.

The loss of water from the drained catchments may also increase macropore flow through the soils in the form of soil pipes developing in deep peat (Holden et al 2006). He found that macropore flow and the number of soil pipes in drained catchments were significantly higher than those on the intact catchments. The study indicated both the number and the size of the pipes increased. This suggests that peat properties can alter over time, changing the structural properties of the peat caused by enhanced desiccation which may not always be reversible simply by a process of ditch blocking (Holden et al 2006). Ramchunder et al (2009) reviewed the impacts of peat drainage on water chemistry and noted multiple and sometimes contradictory findings on carbon, pH, nutrients and metals. In summary, however, he found that the main effects were on the mobilization of metals and pollutants and reduction of instream light penetration (linked to higher turbidity and water colour)

Forest drainage on peats will increase the runoff response of peat areas under wet conditions, but it can also induce increased storage between storms, leading to larger antecedent soil moisture deficits which would tend to reduce stream runoff (Robinson et al (1998)). Holden (2006) suggests that ageing system of drains on steeper slopes should be targeted for ditch blocking because these drains are subject to a greater discharge of sediments and carbon, because these drains expose the deeper layers of peat. He suggests that artificial drainage of peatlands encourages the development of pipes and macropores and this opens the way for water, sediment and nutrients to be transferred from deep within and below the peat rather than just simply transferred rapidly through the aerobic acrotelm (upper peat layer). It seems likely that ditches running up and down slope will produce more rapid flow velocities and so are likely to lead to increased peat erosion compared to ditches excavated along the contours, but little direct evidence for this has been found in the literature. New forest peat drains can increase stream flows initially but as the drains vegetate over time there will be a progressive decrease in the frequency of flow pulses and an increase in pulse duration, so that after 12 years the runoff response had become much less flashy Archer (2003). New forest drains on peatlands affects flows but these affects vary over time. Robinson et al (2003) suggested these effects could last 10 years or longer. In small upland catchments they also suggested that drainage for forestry could double the originally low base flows, but as the tree crop grows again this will decline, depending on the nature of weed growth and accumulation of leaf litter to block the drains. Also, mature forest has a drying effect, lowering the soil water table to beneath the artificial drains, so that the long-term drying is "biological" rather than engineered. They concluded that peak flows from a mature forest cover on peaty soil in north-west Europe may be little different from on unforested land.

Impacts of heavy construction on peatland hydrology include the effects of roads, railways, grouse moor tracks and more recently access tracks for wind farm developments. Gunn et al

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(2001) noted that the hydrological impacts of the turbines themselves are likely to be very limited, the management and engineering of excavated access roads is where the problems are. On these roads the volume of the acrotelm is reduced possibly by more than half, which would in turn reduce permeability, increase saturation and could potentially pond water on the upslope side. Stunnel (2010) noted that the risks associated with construction on deep peat are much greater than those on shallow peat, and that much can be done in the design and construction to reduce impact.

Changes in water quality following drain blocking

O'Brien et al (2008) found that the water table rose after drain blocking and significant rise and fall in water table was observed in the monthly average of daily mean stream flow, suggesting that the catchment was successfully rewetting, but they did not find any statistically significant changes in water colour over the 3 years of the trial. In this trial they found that drains on slopes gentler than 2° rarely eroded and natural infilling of drains often occurred on slopes less than 4° Holden et al (2007). The study observed that drain blocking is an effective treatment for reducing sediment movement, with better-than-expected revegetation response. Sediment transport was found to occur most during winter, even though this was not the time of greatest rainfall. Active drains were a major source of sediment, giving sediment yields around 30-50 t.km-2 during the 12-month study, and accounting for 18.3% of the sediment from only 7.3% of the catchment area. However, drains that had been dammed along their length using peat blocks had very low sediment yields, and even poorly functioning dams were very effective at reducing suspended sediment.

Wallage et al (2006) study at a single blanket peat site, found that DOC and water colour values were significantly greater at the drained site than the intact site, whilst those at the site with blocked drains were significantly lower. There was a contrast in the quality of the carbon from the different areas, with the drained and blocked sites having more of the large molecules of highly coloured humic acids and the intact sites more of the fulvic acids that characterise newly decomposing plant litter. They also looked at the ratio between water colour and DOC and suggested that an elevated ratio at the blocked site indicated continued disturbance to DOC production and transportation, possibly by enhanced microbial activity, despite the lower concentrations found. It should be noted that the drainage and blockage had occurred prior to the start of this study so no direct "calibration period" was available for comparison, and the conclusions do depend upon finding situations which were truly comparable before the intervention took place.

There is not a consensus in the literature with regard the effectiveness of drain blocking on water quality. *According to* Schumann and Joosten (2008, p 22) restoring peat hydraulic conditions is virtually impossible. They suggested that compacted peat prevents the water from entering the peat body and the decreased storage coefficient of the peat leads to larger water level fluctuations, which increases peat decomposition. This means that peatlands where the hydraulic peat properties have been changed often cannot be restored to their former hydrological functioning, but that alternative restoration aims have to be formulated. Worrall et al (2007) said that drain blocking was ineffective for reducing water

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discolouration and DOC, at least in the short term. Their work at Whitendale (blanket peat) showed that mean water colour and DOC were higher in the blocked drains than in unblocked drains or streams. Relative water colour was approximately twice as high in the blocked drains compared to unblocked ones. Streams tended to have higher specific absorbance (ratio of colour to DOC) than the drains and showed a greater increase in water colour after the blockages were installed. However, seasonality effects still seemed to be more important than the effect of the blockage in explaining observed variations. Worrall et al (2008) noted that, the increase in DOC concentration observed in many rivers with extensive peat cover may be indicative of changes in terrestrial carbon reserves as a result of climate change.

6.0 Forest to bog restoration in Great Britain, Scotland and Ireland

Forest to bog restoration refers to the practice of removing an established forest and restoring the original bog habitat. This requires a change of land use from forestry to a blanket bog habitat (NatureScot, 2023). Forest to bog restoration in the EU was funded under Previous LIFE projects, where the main methods involved tree removal with drain blocking. More recent Forest to bog restoration methods now also include ground reprofiling, which is associated with quicker site recover. Forest to bog is almost unique to the Great Britain, Scotland and Ireland and not comparable to other EU countries such as Scandinavia, where the climate is different, peatlands are often naturally forested, land preparation and drainage are less severe, and nutrient status is often higher (Campbell et al., 2019). It is important to note that this tight geographical spread means that generic restoration techniques that maybe applicable across the EU may not be effective in Great Britain, Scotland and Ireland and that separate techniques more applicable to these areas are more appropriate. In the last decade both Great Britain and Scotland have been engaged in Forest to bog restoration and they have developed techniques that suit their peatland types. Their experience can help guide us in Ireland and inform our work practices. What follows is a summary of the Forest to bog experience in both Great Britain and Scotland,

A review of peatlands and forestry in the Great Britain by Campbell et al (2019) established that the main effect of forestry on peatlands include: a) drainage and tree growth reducing the water table, b) fertilisation facilitating peat decomposition, c) shading and needle drop removing the bog vegetation, d) drainage creating a new ridge/furrow micro-topography, e) post felling the site contains stumps, roots, a litter layer and brash mats, all of which is problematic for a functioning blanket bog habitat, and f) Conifer trees regenerating from dormant seed on the deforested surface can be a significant problem for forest-to-bog restoration projects. To counteract these impacts, Campbell et al (2019) made the following recommendations for 'Forest to bog' Restoration in the UK.

1. Restoration projects must reverse the impact of the ridge-furrow cultivation process which continues to persist post-felling, as well as raising the bog water table within the underlying peat mass which have been damaged by the afforestation process.

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2. Surface smoothing techniques and furrow/drain blocking or a combination of both have shown good potential in restoring active blanket bog habitat. Mitigation measures to manage surface runoff (particularly water quality) from restored sites may be required, in the short-term, depending on the method used, site conditions and sensitivity of receptors.
3. The timescale for specialist bog plants to fully recolonise following treatment - and for bare peat to be re-colonised - is likely to be 3-10 years.
4. Conifer regeneration can be dealt with by surface smoothing methods, but otherwise must be removed by additional treatment depending on size and density.

In Scotland, the Forestry Commission (Scotland) have been involved in Forest to bog restoration at scale for over a decade. According to the Forestry Commission Scotland (2015) site selection is based on a "presumption to restore" (Table 2), which sets out high level criteria in the site selection process on a large-scale landscape level. If these criteria were used in Ireland, most of forested sites on the western seaboard would be identified as having potential for restoration. Their research indicates that a negative net greenhouse gas balance may occur from restocking on deep peats where tree growth is poor, even if there is no significant soil disturbance from cultivation. As you would expect, they have observed that the greatest potential for successful and early restoration of peatland into a net carbon sink is generally on the wettest sites which have yielded very poor tree growth. For sites with poor restoration potential, the Forestry Commission Scotland are planting a low-density 'peatland edge woodland' type that is deemed to be more appropriate.

Table 2: The presumption to restore criteria used in Scotland to select sites

	For Commission criteria for bog restoration = Presumption to restore
1	Deep peat (>50 cm) (Can include shallower peats as well)
2	Habitats designated as qualifying features in the UK Biodiversity Action Plan, or on Natura sites, Ramsar sites, Sites of Special Scientific Interest (SSSIs) or National Nature Reserves (NNRs);
3	Sites or parts of sites where restocking is likely to adversely affect the functional connectivity (hydrology) of an adjacent Annex 1 peatland habitat (as defined in the EU Habitats Directive), or a habitat associated with one;
4	Sites where deforestation would prevent the significant net release of greenhouse gases.

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Authors concluding remarks.

The initial afforestation of Irelands blanket bogs occurred in line with the governmental policy of the day and most of these afforested peatlands are now maturing. Concerns about how best to manage them in the future need to be addressed urgently. Unless action is taken now, it might be too late. In the last decade harvesting has begun on these afforested peatlands and is continuing at a pace annually. It was previously assumed that the low productive nature of these sites would mean extra-long rotations and very expensive harvesting. However, this is not the case. Most afforested peatlands were planted with lodgepole pine, which has a short rotation length of between 30 to 40 years. The economic challenges are also offset by the fact that Coillte manages state owned land, which allows them to adopt a net present value approach to forestry. This approach means that past costs are considered 'sunk' making it easier economically to financially justify felling. In addition, as Coillte has now also moved into adding value through its ownership of 2 board mills, it can add value to the raw material (timber) also making it financially more attractive to harvest. The net result is that afforested peatlands are being felled annually at pace. All felling is subject to the Forestry Act which grants felling licenses with a condition to replant with equivalent species. Unless we act now, we will witness a change from afforested western peatlands to reafforested western peatlands. The western peatlands project acknowledges this urgency and is ideally placed to schedule restoration in tandem with harvesting, to ensure that this restoration opportunity is not lost.

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References

Adamson, J.K., Scott, W.A., Rowland, A.P. & Beard, G.R. (2001) Ionic concentrations in a blanket peat bog in northern England and correlations with deposition and climatic variable. European Journal of Soil Science 52, 69-79.

Allott, T.E.H., Evans, M.G., Lindsay, J.B., Agnew, C.T., Freer, J.E., Jones, A., & Parnell, M. (2009) Water tables in Peak District blanket peatlands. Moors for the Future Report No. 17. funded by the Environment Agency and National Trust. Hydrological benefits of moorland restoration.

Archer, D. (2003) Scale effects on the hydrological impact of upland afforestation and drainage using indices of flow variability: the River Irthing, England. Hydrology and Earth Systems Science 7, 3, 325-338.

Andersen, R et al, No date. An overview of the progress and challenges of peatland restoration in Western Europe Environmental Research Institute, University of the Highlands & 4 Islands, Castle St. Thurso, KW14 7JD, UK. Email: roxane.andersen@uhi.ac.uk

Armstrong, A., Holden, J., Kay, P., Francis, B., Foulger, M., Gledhill, S., McDonald, A.T., & Walker, A. (2010) The impact of peatland drain-blocking on dissolved organic carbon loss and discolouration of water; results from a national survey. Journal of Hydrology, 381, 112-120.

Carroll, J, Anderson P, Caporn, S, Eades, P, O'Reilly, C, Bonn, A. 2019. Sphagnum in the Peak District Current Status and Potential for Restoration, Moors for the Future Report No 16.

Campbell D et al, 2009. Peatlands and forestry. IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. Available from https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2019-11/CoI%20Forestry%20and%20Peatlands%20file%20size%20reduced.pdf

Campbell D et al, 2019. Peatlands and forestry. IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. Available from https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2019-11/CoI%20Forestry%20and%20Peatlands%20file%20size%20reduced.pdf

Clark, J.M., Lane, S.N., Chapman, P.J., & Adamson, J.K. (2008) Link between DOC in near surface peat and stream water in an upland catchment. Science of the Total Environment, 404, 308-315.

Cross, J.R. (1973) The ecology and control of Rhododendron ponticum (L.) with special reference to the Killarney National Park. PhD Thesis, University of Dublin, Trinity College

Edwards, C. (2006). Managing and controlling invasive rhododendron. Forestry Commission Practice Guide.

Evans, M.G and Warburton, J. (2007) Geomorphology of upland peat: erosion, form and landscape change. Oxford : Blackwell Publishing.

Evans, M.G., Burt, T.P., Holden, J., & Adamson, J.K. (1999) Runoff generation and water table fluctuations in blanket peat: evidence from UK data spanning the dry summer of 1995. Journal of Hydrology, 221, 141-160.

Farrell, E. P. 1997. Managing our forests for the future. Irish Forestry 54 (1): 38-48.

Forestry Commission Scotland, 2015. Deciding future management options for afforested deep peatland, Forestry Commission Scotland Practice Guide, Forestry Commission, Edinburgh. i–iv + 1–20 pp. 2015.

Forest Service, 2012. Afforestation of Unenclosed Land, Forest Service position paper regarding afforestation on unenclosed land Prepared for the CCLAWG-Interim Report, 2012.

Foss, P., 1998, National overview of the peatland resource of Ireland. In: O'Leary, G., and Gormley, F., (Eds.): Towards a conservation strategy for the bogs of Ireland pp. 3-20. Irish Peatland Conservation Council, Dublin.

Gibson, H.S., Worrall, F., Burt, T.P., & Adamson, J.K. (2009) DOC budgets of drained peat catchments: implications for DOC production in peat soils. Hydrological Processes, 23, 1901-1911.

Received
0 8 JAN 2024
Planning & Development Section
Galway County Council

Gilman, K. (1994) Hydrology and Wetland Conservation. John Wiley & sons, Chichester.

Gunn, J., Labadz, J.C., Dykes A.P., Kirk K.J., Poulson S.J. & Matthews, C. (2002) Blanket Bog Hydrology at Mynydd Hiraethog SSSI: an investigation of peat properties and hydrology and assessment of effects of proposed wind farm construction . Countryside Council for Wales Research Report no 501.

Higgins, G.T. (2008) Rhododendron ponticum: A guide to management on nature conservation sites. Irish Wildlife Manuals, No. 33. National Parks and Wildlife Service.

Holden, J. (2006) Sediment and Particulate Carbon Removal by Pipe Erosion Increase over Time in Blanket Peatlands as a Consequence of Land Drainage. Journal of Geophysical Research, 111. F02010, doi:10.1029/2005JF000386.

Holden, J. & Burt, T.P. (2002) Laboratory experiments on drought and runoff in blanket peat. European Journal of Soil Science, 53, 675-689.

Holden, J. & Burt, T.P. (2003) Hydrological studies on blanket peat: the significance of the acrotelm-catotelm model. Journal of Ecology, 91, 86-102.

Holden, J., Evans, M.G., Burt, T.P., & Horton, M. (2006) Impact of land drainage on peatland hydrology. Journal of Environmental Quality, 35, 1764-1778.

Holden, J., Gascoign, M., & Bosanko, N.R. (2007) Erosion and natural revegetation associated with surface land drains in upland peatlands. Earth Surface Processes and Landforms, 32, 1547-1557.

Irish Peatland Conservation Council, 2021. Peatlands and Climate Change Action Plan 2030. Irish Peatland Conservation Council, Bog of Allen Nature Centre, Lullymore, Rathangan, Co. Kildare R51V293. Email: bogs@ipcc.ie. Web: www.ipcc.ie

Ivanov, K.E. (1981) Water movement in Mirelands. Academic Press, London.

Jenkins, G.J., Murphy, J.M., Sexton, D.S., Lowe, J.A., Jones, P., & Kilsby, C.G. (2009)

Jones, J.A.A. (2004) Implications of natural soil piping for basin management in upland Britain. Land Degradation & Development, 15, 325-349.

Joosten, H., & Clark, D. (2002). Wise Use of Mires and Peatlands. Saarijärvi: International Mire Conservation Group and International Peat Society.Retrieved 2017, from http://www.imcg.net/media/download_gallery/books/wump_wise_use_of_mires_and_peatlands_book.pdf

Labadz, J.C., Hart, R. G. & Butcher, D.P. (2007) Peatland Hydrology Research Project: Bolton Fell Moss (NGR NY489690) and Walton Moss (NGR NY489690). Nottingham Trent University - Progress Report to Natural England.

Labadz et al., 2010. Peatland Hydrology. Draft Scientific Review IUCN UK Peatland Programme's commission of Inquiry on Peatlands. Available from https://www.iucn-uk-peatlandprogramme.org/sites/www.iucn-uk-peatlandprogramme.org/files/Review%20Peatland%20Hydrology,%20June%202011%20Draft_0.pdf

Lindsay, R. A. (2010). Peatbogs and carbon: a critical synthesis to inform policy development in oceanic peat bog conservation and restoration in the context of climate change. Commissioned Report to the Royal Society for the Protection of Birds (RSPB).

NatureScot, 2023. Peatland ACTION - Technical Compendium. nature.scot/doc/peatland-action-technical-compendium

O'Brien, H., Labadz, J.C., Butcher, D.P., Billet, M., & Midgley, N. (2008) Impact of catchment management upon dissolved organic carbon and stream flows in the Peak District, Derbyshire, UK. In Proceedings of the BHS National Symposium "Sustainable Hydrology for the 21st Century, University of Exeter.

Received
0 8 JAN
Planning & Development Section
Galway County Council

Price, J.S., Heathwaite, A.L. & Baird, A.J. (2003) Hydrological processes in abandoned and restored peatlands: an overview of management approaches. Wetlands, ecology and management 11, 65-83.

Ramchunder, S.J., Brown, L.E., & Holden, J. (2009) Environmental effects of drainage, drain-blocking and prescribed vegetation burning in UK upland peatlands. Progress in Physical Geography, 33, 49-79.
Renou, F. and Farrell, E.P., 2005. Reclaiming peatlands for forestry: the Irish experience. http://www.ucd.ie/ferg/Research/Topics/L1635_C34.pdf.

Robinson, M., Moore, R.E., Nisbet, T.R. & Blackie, J.R. (1998) From moorland to forest: the Coalburn catchment experiement, Institute of Hydrology Report No. 133, Wallingford.
Robinson, M., Cognard-Plancq, A.L., Cosandey, C., David, J., Durand, P., Fuhrer, H.-W., Hall, R., Hendriques, M.O., Marc, V., McCarthy, R., McDonnell, M., Martin, C., Nisbet,T.,O''Dea, P., Rodgers,M. & Zollner,A. (2003) Studies of the impact of forests on peak flows and baseflows: a European perspective. Forest Ecology and Management 186, 85-97.

Rotherham, I.D. (1983). The ecology of Rhododendron ponticum with special reference to its competitive and invasive capabilities, Department of Botany, University of Sheffield.

Schumann, M. and Joosten., H. (2008) Global Peatland Restoration Manual, Vol. 2010. Institute of Botany and Landscape Ecology, Greifswald University, Germany. Available at http://www.imcg.net/docum/prm/gprm_01.pdf (accessed July 2010)

Shaw, S., Wheeler, B., & . (1994). Monitoring Raised Bogs., Rep. No. 189. English Nature, Peterborough.

Stunnel, J. (2010) Investigating wind farms on peat. Report to Natural England no NECR032. Maslen Environmental. Available at: http://naturalengland.etraderstores.com/NaturalEnglandShop/NECR032

Maltby, E., Legg, C.J. and Proctor, M.C.F. (1990) The ecology of severe moorland fire on the North York Moors – effects of the 1976 fires, and subsequent surface and vegetation development. Journal of Ecology, 78 (2), 490-518.

Tiernan, D., 2004. Strategy for the Future Management of Low Production Forests (Western Peatland Forestry). Coillte Teoranta, Newtownmountkennedy, Co. Wicklow, Ireland.

Wallage, Z.E., Holden, J., & McDonald, A.T. (2006) Drain blocking: An effective treatment for reducing dissolved organic carbon loss and water discolouration in a drained peatland. Science of the Total Environment, 367, 811-821.

Worrall, F., Armstrong, A., & Adamson, J.K. (2007) The effects of burning and sheep-grazing on water table depth and soil water quality in a upland peat. Journal of Hydrology, 339, 1-14.

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APPENDIX 7

INVASIVE SPECIES MANAGEMENT PLAN OBSERVATIONS

Appendix 1: Observations

Observations on mapping rhododendron using the 10m transect method.

Manually mapping invasives is not easy and it is expensive. Knowing the exact locations of individual plants using point features on a map is useful when the infestation is low, but when the infestation level is high, using a polygon feature on a map is more practical. The use of remote sensing and drones should be explored as a reasonable alternative. The heat map approach using the DAFOR method produces good results but cannot provide granular detail. The bespoke 10m sampling transect method described above produces very accurate maps and establishes a detailed baseline, but it is labour intensive. This method took 3 people 10 days to complete, and it covered an area of 350, equating to covering approximately 35 ha per day. While 90% of the area was assessable, certain areas were not assessable for two main reasons. Firstly, in some areas the levels of infestation were too high to physically allow access. In these areas, the perimeter was mapped, and a polygon created to identify these areas as polygons, as opposed a point features. Secondly, in other areas the area was inaccessible due to dense forestry vegetation (such as thicket stage crops or blown areas). In these areas, the perimeter was mapped, and a polygon created to identify that these areas were not part of the survey. The 10m sampling transect method is a very costly and demanding physically. The purpose for which the data will be subsequently used should be ascertained before deciding on using this method. Ultimately, any survey will be used to inform the operational plan to manage the invasives. In the case of Derryclare, the operational plan is to have an annual management intervention across the entire site for 7 to 10 years, as a means of dealing with invasives. In this instance, it is questionable why a detailed survey is needed, other than to provide a detailed baseline. In addition, subsequent site inoculation post ground disturbance from the felling and restoration activities will not be captured in the baseline and these will require supplementary surveys.

Observations on recent advances on mapping rhododendron.

Some initial trials were conducted using LIDAR, RGB and multispectral imagery and different platforms (aircraft and drones) to detect and map the extent of rhododendron cover. Dense canopy cover can prevent detection, and in some instances the differentiation of rhododendron from other young vegetation (particularly Sitka spruce regeneration) is less distinct resulting in false positives. These techniques particularly in areas with forest cover and mixed vegetation are still proving to be challenging and further work is needed to refine the process.

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