EARBA STORAGE

A GILKES ENERGY COMPANY

Earba Pumped Storage Hydro Scheme

EIA Report

Chapter 11: Aquatic Ecology

February 2024

Quality Information

Prepared by	Checked by	Approved by
Gavia Environmental	Chris Pasteur	Gavin McGill

Revision History

Revision	Revision Date	Details	Authorised
01	February 2024	Issue to ECU	Gavin McGill

Contents

11.1 Executive Summary

This Chapter considers the potential effects, including cumulative effects, of the Proposed Development on aquatic ecology (including fish fauna, fish habitat, macroinvertebrates and macrophytes) during construction and operation.

The scope of the assessment was informed by scoping responses received from statutory and non-statutory consultees and further consultation undertaken after the formal scoping exercise as the design of the Proposed Development was developed in response to the findings of site surveys.

The assessment of effects within this Chapter is informed by desk based and field survey data. Baseline surveys were undertaken in accordance with relevant good practice guidelines between Autumn 2022 and Autumn 2023.

Where likely significant effects are predicted during construction and operation, appropriate mitigation measures are proposed to minimise the impact on the nature conservation feature, and the significance predicted residual effects are assessed.

Construction and Operational Residual

The Proposed Development would comprise a number of principal activities during the construction phase that could potentially result in significant negative effects on aquatic ecology. These are the construction of the Leamhain Dam and upper reservoir, the Shuas and Shios Dams and lower reservoir, construction of the upper and lower control works, construction of the Pitridh and Shuas aqueducts, and the operation of borrow pits and the use of site establishment and lay down areas. During operation of the Proposed Development, the presence of the dams and the operation of the reservoirs could potentially result in significant negative effects on aquatic ecology.

After mitigation, the residual construction and operational effects are as follows:

- Impacts with a significant effect on Arctic charr were identified during the construction and operational phase after mitigation including: noise and vibration during construction (**Minor, Not Significant**); dust and surface run off from construction work (**Minor, Not Significant**); construction lighting (**Minor, Not Significant**); loss of spawning substrate (**Minor, Not Significant**); and loss of access to watercourse spawning substrate (**Moderate, Significant**).
- Impacts on brown trout were identified during the construction and operational phase after mitigation including: noise and vibration during construction (**Not Significant**); dust and surface run off from construction work (**Minor, Not Significant**); construction lighting (Not Significant); loss of spawning substrate (**Minor, Not Significant**); and loss of access to watercourse spawning substrate (**Minor, Not Significant**).
- Impacts on macroinvertebrates were identified during the construction and operational phase prior to mitigation including: construction lighting (**Not Significant**); and dust and surface run-off from construction (**Moderate, Significant**). The significance of these effects after mitigation is considered **Minor, Not Significant**.
- Impacts on macrophytes were identified during the construction and operational phase prior to mitigation include construction lighting. The significance of these effects after mitigation is considered **Not Significant**.

No cumulative residual effects were identified.

11.2 Introduction

11.2.1 This Chapter considers the potential effects, including cumulative effects, of the Proposed Development on aquatic ecology during construction and operational periods. Potential effects on other ecological features are considered separately in the respective EIAR chapters terrestrial ecology (Chapter 8), forestry (Chapter 9) and ornithology (Chapter 10).

11.2.2 Aquatic ecology survey work was commissioned to inform the Impact Assessment process for the Proposed Development. All surveys undertaken were done in accordance with the relevant Scoping Opinion responses. Surveys were undertaken in accordance with best practice guidelines and methodologies.

11.2.3 This Chapter is supported and informed by a Technical Appendix Report on Aquatic Ecology (**Appendix 11.1**), which presents the results of the field surveys.

11.2.4 As detailed in Chapter 3: Description of Development, with proper maintenance the Proposed Development would remain functional indefinitely. If the project were to be decommissioned, it is anticipated that the potential effects on aquatic ecology would be equal to or lesser than the construction impacts. As such, a separate assessment of potential decommissioning effects on aquatic ecology is not included in this chapter. Where significant effects, as defined under the EIA Regulations, are predicted during construction and operation, appropriate mitigation measures are proposed, and the significance of predicted residual effects are assessed.

11.2.5 This assessment has been carried out by Gavia Environmental Ltd. A table presenting relevant qualifications and experience of key staff involved in the preparation of this Chapter is included in **Appendix 1.1 – EIA Specialist Team** of this EIA Report.

11.3 Scope of Assessment

Study Area

11.3.1 The Study Area encompasses the area over which all desk-based and field data were gathered to inform the assessment presented in this Chapter. The Study Area comprises all watercourses and waterbodies contained within and flowing into and out of the red line boundary area, as well as ‘control’ areas also covered within the red line boundary but outwith the area affected by the Proposed Development.

11.3.2 The study area for the desk study is a 10 km radius from the Site boundary for international statutory designated sites, and a 2 km radius for protected and notable species records, national or local statutory designated sites, and non-statutory designated sites. For designated sites for aquatic features, hydrological connectivity is considered when assessing likely significant effect. Areas included are shown on **Figures 1 and 2**.

Zone of Influence

11.3.3 The ‘zone of influence’ for a project is the area over which ecological features may be affected by biophysical changes which may be a result of the Proposed Development and associated construction and operational activities. For aquatic features, this is likely to extend beyond the planning boundary, for example where

there are ecological or hydrological links beyond the Site. The zone of influence will vary for different ecological features depending on their sensitivity to an environmental change. It may therefore be appropriate to identify different zones of influence for different features. The scoping exercise narrowed down the important ecological features. The zone of influence has been set for each one (see **Table 11.1** below).

Table 11.1 Zone of Influence - Important Ecological Features

Important Ecological Feature	Nature Conservation Level	Rationale for Selection	Zone of Influence
Arctic charr *Salvelinus alpinus*	National	Arctic charr are of National UK importance and are a UKBAP Priority species (added in 2007) considered to be 'Vulnerable' (most recent classification 2023[1]). Scotland represents a stronghold for Arctic charr in Europe, with populations recorded in 258 lochs; although populations have undergone declines in recent years. Spawning Arctic charr are known to spawn between autumn / late winter / early spring[2]. Populations are known to primarily utilise loch marginal habitat however they have been recorded at a range of depths: 1-3 m (Lake Windemere); 15-20 m (Lake	Affected areas of Loch Earba (East and West) and tributaries adjoining, Loch Leamhain and the Allt Loch a' Bhealaich Leamhain.

[1] Nunn, A. D., Ainsworth, R. F., Walton, S., Bean, C. W., Hatton-Ellis, T. W., Brown, A., Evans, R., Atterborne, A., Ottewell, D., Noble, R. A. A. (2023). Extinction risk and threats facing the freshwater fishes of Britain. *Aquatic Conservation: Marine and Freshwater Ecosystems.* 1-17.

[2] Klemetsen, A., Amundsen, P. A., Dempson, J. B., Jonsson, B., Jonsson, N., O'Connell, M. F. and Mortensen, E. (2003). Atlantic salmon *Salmo salar L*., brown trout *Salmo trutta L*. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. *Ecology of Freshwater Fish*. 12: 1-59.

Important Ecological Feature	Nature Conservation Level	Rationale for Selection	Zone of Influence
		Windemere)[3]; and <1.24 m (average of Irish loughs). Specific populations in Scotland occasionally spawn in riverine habitat.	
Brown trout *Salmo trutta*	Local	Brown trout are a UKBAP priority species and listed as of National UK importance (JNCC, 2007). Small, isolated populations of resident brown trout, similar to that present in Loch Leamhain, are widespread in upland lochs, streams and rivers in the Highland region, and Scotland. Spawning Brown trout are predominantly recorded utilizing riverine and marginal habitats, and a combination of both to spawn. They are more likely to spawn in rivers than other salmonids (i.e. Arctic charr).	All affected watercourses and Lochs.
Macroinvertebrates	National (P. convenntus) Local (all other macroinvertebrates)	One species present, *Pisidium conventus* (Arctic-alpine pea mussel), is considered an Important Ecological Feature (IEF). All other macroinvertebrates have been scoped out of this assessment except where they are present as a food	Allt Loch a' Bhealaich Leamhain (for Arctic-alpine pea mussel). All watercourses and marginal loch areas (all macroinvertebrates).

[3] Frost, W.E. (1965). Breeding habits of Windermere charr, *Salvelinus willughbii (Günther)* and their bearing on speciation of these fish. Proceedings of the Royal Society, Series B. 163(473). pp. 232-284.

Important Ecological Feature	Nature Conservation Level	Rationale for Selection	Zone of Influence
		source for other IEFs. *P. conventus* are included on the Scottish Biodiversity List, classed as Vulnerable on the Red List, and considered Nationally Rare[4].	
Macrophytes (higher plants)	Local	Macrophytes support large macroinvertebrate populations which provide an important food source for littoral zone feeders, such as brown trout, and refugia for fish. Other species, e.g. waterfowl are dependent on macroinvertebrates, this is considered in the Chapter: 8 Terrestrial Ecology.	Marginal areas of Loch Earba (East and West) and Loch Leamhain.

Consultation Responses

11.3.4 To inform the scope of the assessment for the Proposed Development, consultation was undertaken with statutory and non-statutory bodies. Table [11.2] summarises the scoping and consultation responses relevant to aquatic ecology and provides information on where and/or how points raised have been addressed in this assessment.

11.3.5 Full details on the consultation responses and scoping opinion can be reviewed in Chapter 5: Scoping and Consultation, and associated appendices.

Table 11.2 Consultation Responses

Consultee	Issue Raised	Response/Action Taken
Energy Consents Unit (ECU) Scoping 27/04/23	The Marine Directorate of the Scottish Government provide advice for hydro development which outlines what information, relating to freshwater and diadromous fish and fisheries, is expected in the EIA report.	Predominately Actioned in EcIA.
The Highland Council (THC)	The EIAR needs to address the nature of the hydrology and hydrogeology of the land, and of	Potential impacts can be found in **Section 11.8**.

[4] NBN Atlas. (2023). Pisidium conventus. [Online] Available at: https://species.nbnatlas.org/species/NHMSYS0021342644

Consultee	Issue Raised	Response/Action Taken
Scoping 27/04/23	the potential impacts on water courses, water supplies including private supplies, water quality, water quantity and on aquatic flora and fauna. Impacts on watercourses, lochs, groundwater, other water features and sensitive receptors, such as water supplies, need to be assessed. Measures to prevent erosion, sedimentation or discolouration will be required, along with monitoring proposals and contingency plans.	Mitigation can be found in **Section 11.7** and **11.9.**
	Aquatic environment: The EIA must consider the impact of reduced water flow into the outflow watercourses from both Lochs and Loch Laggan.	Potential impacts can be found in **Section 11.8**.
Scottish Environmental Protection Agency (SEPA) Scoping 27/04/23	Loss of brown trout habitat will need to be assessed. Further information on requirements is available on our website at: Fish and fish habitat | Scottish Environment Protection Agency (SEPA).	Loss of habitat can be found in **Section 11.8**.
	Other elements of the scheme must be designed to avoid impacts upon the water environment. Where activities such as watercourse crossings, watercourse diversions or other engineering activities in or impacting on the water environment cannot be avoided then the submission must include justification of this and a map showing: a) All proposed temporary or permanent infrastructure overlain with all lochs and watercourses. b) A buffer of at least 10m drawn around each loch or watercourse. If this minimum buffer cannot be achieved each breach must be numbered on a plan with an associated photograph of the location, dimensions of the loch or watercourse and drawings of what is proposed in terms of engineering works. c) Detailed layout of all proposed mitigation including all cut off drains, location, number and size of settlement ponds.	Outwith scope of Aquatic Ecology chapter.
NatureScot Consultation / scoping 27/04/23 and 02/06/2023	We broadly agree with the proposed scope of surveys and assessments to be included in the EIAR; these generally meet the requirements we would expect. However, we advise that extra information is included in the EIAR should this scheme progress to full application.	Surveys undertaken to inform this EIAR can be found in **Section 11.6.**
	Therefore the EIAR should include a pollution prevention plan which fully details mitigation and emergency measures to prevent pollution entering the watercourses 'Allt Loch a' Bhealaich Leamhain' and 'Allt Cam' and	Mitigation measure can be found in **Section 11.9.**

Consultee	Issue Raised	Response/Action Taken
	ultimately Loch Pattack and its surrounding habitats.	
	NatureScot was consulted on the presence of Freshwater Pearl Mussels, *Margaritifera margaritifera,* within the catchment. NatureScot suggested that they '*don't hold any records for the catchments listed*'' and that the area is unlikely to have any '*appropriate freshwater pearl mussel (FWPM) habitat that would be affected by the proposal*'', therefore surveys were not recommended.	No further action taken.
Marine Scotland Consultation / scoping 27/04/23	The Marine Directorate welcome the proposed baseline fish surveys in watercourses. We advise that fully quantitative electrofishing surveys should be carried out in all watercourses that are at risk of an impact associated with the proposed development. All obstacles to fish migration should be assessed over a range of flows. A fish habitat survey should be carried out in line with guidance issued by SEPA.	Actioned in Technical Appendix surveys and EIAR. A summary of surveys undertaken can found in **Section 11.6.**
	The Marine Directorate advise that gill netting should be carried out in the lochs using standard protocols … to provide information on the presence and abundance of the different fish species. We also advise the use of eDNA as an additional means of determining presence of fish species which may be in low abundance. The proposed hydroacoustic surveys should provide information on the distribution of fish species which are identified in the netting and eDNA surveys. The proposed salmonid spawning habitat suitability surveys should also be informed by what fish species are present in the lochs and their most likely spawning habitats e.g. brown trout are most likely to spawn in the watercourses.	Actioned in Technical Appendix surveys and EcIA. Summary of surveys undertaken can found in **Section 11.6.**
	We welcome the proposed macroinvertebrate surveys of the potentially impacted lochs and outflow watercourses. All surveys should be carried out in line with SEPA guidelines.	Actioned in Technical Appendix surveys and EcIA. Summary of surveys undertaken can found in **Section 11.6.**
	Full details of all survey work including methodology, sampling dates, a list of the fish species, their abundance, fish habitat use and availability and associated fisheries should be presented in the EIA report. The results of the baseline surveys should inform a full and rigorous assessment by the developer of the potential impacts of the proposed development	Actioned in the EcIA. Summary of surveys undertaken can found in **Section 11.6.**

Consultee	Issue Raised	Response/Action Taken
	on the fish populations, habitat and associated fisheries.	
	In addition to the potential impacts listed in the scoping report, the Marine Directorate advise ECU that the developer should consider the potential change in fish behaviour, injury and /or mortality due to noise and vibration associated with construction works and the operation of the development. The potential for any changes in water quality (e.g. the release of sediment, hydrocarbons, as a result of a fuel spillage, and/or concrete) or quantity acting directly or indirectly on fish populations should also be considered	Potential impacts can be found in **Section 11.8**.
	We advise that the developer should consider the potential impact on the littoral zone of all lochs and fish access in the watercourses which may be impacted from the differing water levels in the lochs	Potential impacts can be found in **Section 11.8** and mitigation measures in **Section 11.9** during the Construction and Operational Phase.
	The Marine Directorate advise that the potential cumulative impact on the fish populations of Loch Laggan as a result of the proposed Earba hydroelectric scheme and other developments (consented and operational) within hydrological connectivity e.g. the Ardverikie and Pattack hydroelectric schemes should be considered as should the resilience of the fish populations to all potential impacts.	Addressed in Section 11.8.58-60.
Ardverikie Estate Correspondence 17/01/2023	The estate advised no angling records are available for Loch Earba or Loch Leamhain, with brown trout being the sole species identified in Loch Earba.	No further action taken.
Lochaber District Salmon Fishery Board Correspondence 16/05/2023	'The scheme is above the limit for migratory fish so we will not be responding. Our remit is limited to migratory salmonids.'	Migratory fish are not considered within this EIAR.
BugLife Scotland Correspondence 10/02/24	Lack of information on *Pisidium conventus.*	No further action necessary for the EcIA; records should be provided to the National Record Centre.

11.3.6 The following organisations of relevance to the aquatic interest covered in this Chapter were consulted but did not provide a response:

- Crown Estate Scotland;
- Fisheries Management Scotland;

- Lochaber Fisheries Trust; and
- Scottish Wildlife Trust;

11.3.7 With regard to those consultees who did not respond, it is assumed that they have no comment to make on the scoping report.

Issues Scoped out of Assessment

11.3.8 Ecological features have been scoped out of further assessment where the feature does not have a level of nature conservation at a local level or above, where there is no potential for significant effect upon the features or is not subject to legal protection.

11.3.9 Migratory fish presence has been scoped out of the assessment due to the cumulative effect of multiple known impassable barriers downstream with no fish passes installed (Barrier ID's: 20658; 3266) and the scoping response from the Lochaber District Salmon Fishery Board suggesting 'the scheme is above the limit for migratory fish'.

11.4 Legislation, Policy and Guidance

Legislative Context

11.4.1 The following legislation has been considered in the assessment:

- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora;
- Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy - the 'Water Framework Directive' (WFD);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (The Habitat Regulations) as amended in Scotland;
- The Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003;
- Wildlife and Countryside Act 1981 (as amended) (the 'WCA');
- Nature Conservation (Scotland) Act 2004 (as amended);
- Wildlife and Natural Environment (Scotland) Act 2011 (as amended);
- Planning (Scotland) Act 2019;
- Regulation 1143/2014 on invasive alien species (the Invasive Species Regulation) (as amended in Scotland); and
- Reservoirs (Scotland) Act 2011.

Policy Context

11.4.2 The following policy has been reviewed and applied as appropriate in this assessment:

- National Planning Framework 4 (NPF4) (2023)[5];

[5] Scottish Government. (2023). National Planning Framework 4. [Online] Available at: https://www.gov.scot/publications/national-planning-framework-4/ [Accessed in August 2023].

- Highland-wide Local Development Plan (2012): Policies 28 (Sustainable Design); 59 (Other important species); 60 (Other Important Habitats); 63 (Water Environment); 67 (Renewable Energy Developments)[6]; and
- Highland's Statutory Protected Species Supplementary Guidance[7].

Technical Guidance

11.4.3 The following technical guidance has been considered in the assessment:

- Circular 1/2017: Environmental Impact Assessment Regulations[8];
- Lochaber Fisheries Trust Management Plan (2008)[9];
- CIEEM (2018, amended 2022) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester[10];
- Environment Agency (2005) Screening for Intake and Outfalls: a best practice guide[11];
- Highland Nature: Biodiversity Action Plan 2021 – 2026[12];
- SEPA (2010) Engineering in the water environment: good practice guide River crossings Second edition, November 2010[13]; and
- SEPA (2017) Guidance for Pollution Prevention (GPPs)[14].

11.5 Methodology

Desk Study

11.5.1 In order to anticipate the potential ecological sensitivities on aquatic features associated with the Proposed Development, a desk study was conducted in advance of the field surveys. This included a review of:

[6] The Highland Council. (2022). Highland Wide Local Development Plan April 2012. [Online] Available at: https://www.highland.gov.uk/info/178/development_plans/199/highland-wide_local_development_plan [Accessed in August 2023].

[7] The Highland Council. (2013). *Highland Statutorily Protected Species Supplementary Guidance.* [Online] Available at: https://www.highland.gov.uk/downloads/file/3026/highland_statutorily_protected_species_supplementary_guidance [Accessed in August 2023].

[8] Scottish Government. (2017). Planning Circular 1/2017: Environmental Impact Assessment regulations. [Online] Available at: https://www.gov.scot/publications/planning-circular-1-2017-environmental-impact-assessment-regulations-2017/

[9] Lochaber Fisheries Trust. (2008). Lochaber Fisheries Management Plan. [Online] Available at: https://www.yumpu.com/en/document/read/39239531/lochaber-fisheries-management-plan-2-rafts/9 [Accessed in September 2023].

[10] CIEEM. (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland. [Online] Available at: https://cieem.net/wp-content/uploads/2018/08/ECIA-Guidelines-2018-Terrestrial-Freshwater-Coastal-and-Marine-V1.2-April-22-Compressed.pdf [Accessed in August 2023].

[11] Environment Agency. (2005). Screening for Intake and Outfalls: a best practice guide. [Online] Available at: https://assets.publishing.service.gov.uk/media/5a7c9293ed915d6969f45d2d/scho0205bioc-e-e.pdf [Accessed in August 2023].

[12] Highland Nature Biodiversity Action Plan. [Online] Available at: https://www.highlandenvironmentforum.info/biodiversity/action-plan/ [Accessed in August 2023].

[13] SEPA. (2010). Engineering in the water environment: good practice guide. River Crossings. 2nd Eds. [Online] Available at: https://www.sepa.org.uk/media/151036/wat-sg-25.pdf [Accessed in August 2023].

[14] SEPA . (2017). Guidance for Pollution Prevention and Control (PPC) Technical Guidance. [Online] Available at: https://www.sepa.org.uk/media/335958/ied-ppc-tg4-ppc-part-a-practical-guide.pdf [Accessed in August 2023].

- Ardverikie Estate angling records (Ardverikie Estate 2023, personal communication) ;
- NatureScot (2023) Sitelink for existing data on designated sites within 10 km (international and national conservation designation) and 2 km (local designations)[15];
- Scotland's Environment Web (2023) for data on obstacles to fish migration[16];
- SEPA Water Classification Hub (2023) for river classifications[17];
- Other pre-existing biological data relevant to the Proposed Development were also searched for to which the authors had access and were in the public domain and did not have a non-commercial copyright licence (CC-BY-NC) for example data from NBN Atlas (2023)[18];
- The Joint Nature Conservation Committee (JNCC) (2023) website and NatureScot river macrophyte database and standing waters database were accessed for habitat definitions[19];
- Two relevant, existing hydro schemes are considered within this EIAR: the 1 MW Ardverikie Hydro scheme and the 75 MW Lochaber Hydropower scheme.

Field Survey Methodology

11.5.2 The Ecological Impact Assessment (EcIA) presented here has been informed by a series of technical field surveys, as described in **Section 11.6 Baseline Conditions.**

Macroinvertebrate Surveys

11.5.3 Macroinvertebrate surveys were undertaken in relevant watercourses and waterbodies within two seasons (Spring/May and Autumn/September) in 2023. Survey locations were chosen to be representative of the features in the catchment and to establish good baseline information on areas likely to be affected by the Proposed Development (in line with most recent design information). The methodology employed was the standard Scottish Environment Protection Agency / Environment Agency kick sample method; all individuals collected were identified to species level.

Water Quality Monitoring

11.5.4 *In-situ* water quality was assessed in tandem with macroinvertebrate survey locations in relevant watercourse and waterbody locations in May and September 2023. Parameters monitored included: Temperature (°C); pH; Electrical

[15] NatureScot. (2023). Sitelink. [Online] Available at: https://sitelink.nature.scot/map [Accessed in August 2023].

[16] Scotland's Environment Web. (2023). Scotland's Environment Map. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed in August 2023].

[17] SEPA. (2023). Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed in August 2023].

[18] NBN Atlas. (2023). Locations. [Online] Available at: https://nbnatlas.org/

[19] Joint Nature Conservation Committee. (2023). River Macrophytes Database. [Online] Available at: https://hub.jncc.gov.uk/assets/0a26368d-400c-44e1-beaf-d4b89b7badcd#:~:text=The%20macrophyte%20survey%20method%20records,is%20used%20to%20aid%20recording [Accessed in August 2023].

conductivity (µS/cm); Dissolved oxygen (mg/L) and (%); Dissolved Oxygen (expressed as mg/l and %); Turbidity (Nephelometric turbidity units); and Oxidative Reduction Potential (mV). *Ex-situ* monitoring was not conducted as part of this report.

Fish Habitat Surveys

11.5.5 Ecologists undertook baseline watercourse and waterbody shoreline fish habitat assessments in December 2022 in accordance with SFCC guidance. Fish watercourse habitat was re-categorised in accordance with the 'SEPA fish and fish habitat guidance' (in line with the Scoping Opinion) in July 2023. Surveys categorised watercourses into four primary categories: Bedrock channels; Lamprey habitat; Productive habitat; and Obstructions to migration. An additional habitat of 'Not suitable' was introduced to account for watercourses that held no value as a habitat to support fish (e.g. was completely dry at the time of survey). Productive habitat was sub-categorised into Productive (low), Productive (moderate) and Productive (high) to place emphasis on high quality habitat and to prevent the over-valuation of low quality habitat. Any areas suitable for salmonid spawning were additionally noted.

Fish Ecology Surveys

11.5.6 Fish ecology surveys were undertaken to establish distribution, species and populations present throughout the watercourses and waterbodies within the zone of influence from the Proposed Development. Electrofishing surveys conducted in July 2023; fully-quantitative methods were employed in small watercourses and semi-quantitative in waterbody margins, in accordance with best practice guidance from the SFCC. Gillnetting surveys were undertaken over two weeks between August to September 2023 (covering optimal survey periods) to establish Arctic charr presence and population abundance in Loch Earba (East and West) and Loch Leamhain. Gillnetting on Loch Leamhain could not be undertaken due to weather and safety restrictions (boat access issues and very high winds), so eDNA (qPCR) was undertaken in October 2023 as an alternative survey method.

Macrophyte Surveys

11.5.7 Macrophyte (Higher Plant) surveys were undertaken in September 2023 (after correspondence with SEPA in August 2023) on Loch Earba (East and West) and Loch Leamhain, specifically to establish the presence of any invasive non-native species that may be spread to additional waterbodies via the transfer of water between the upper and lower loch.

Assessment Methodology

11.5.8 The EcIA was undertaken following good practice guidelines current at the time of writing (CIEEM, 2018 as amended). A summary of this methodology is provided below:

- Identify and characterise Important Ecological Features (IEFs);
- Identify and characterise impacts and their effects;
- Identify measures to avoid and mitigate effects;
- Assess the significance of any residual effects after mitigation;
- Identify appropriate compensation measures to offset significant residual effects; and

- Identify opportunities for ecological enhancement and monitoring.

Evaluation of Important Ecological Features

11.5.9 Evaluation of IEFs are applied to those sites, habitats and species (IEFs) that have been scoped into the assessment and those that are predicted to be affected by the Proposed Development. **Table 11.3** gives examples of how different types of IEFs may be evaluated geographically.

Table 11.3 Evaluating Important Ecological Features (IEFs) Geographically

Level of Nature Conservation Value	Examples of Receptors
International (including European)	European sites: SPAs and SACs, (p)SPAs and (c)SACs Other International sites: Ramsar wetlands Habitats and populations of species that represent the qualifying interests of internationally designated sites.
National	Site of Special Scientific interest (SSSI) (biological). All populations of Wildlife and Countryside Act (1981) (as amended in Scotland) Schedule 8 plants. Presence of Annex 1 habitat (i.e., a. blanket bog and Groundwater Dependent Terrestrial Ecosystems (GWDTE)). All viable populations of species listed as Critically Endangered, Endangered, Vulnerable or Threatened in relevant Red Data Books. Nationally important population /assemblage of an European Protected Species (EPS), Schedule 1 and/or 5 species.
Council	Sites/populations that meet SSSI designation criteria but have not been designated due to there having been better examples in the relevant Area Of Search. Regionally important population/area of a species and habitat of Principal Importance or SBL priority species and habitats. Regionally important population/assemblage of an EPS, Schedule 1 and/or 5 species. Regionally important assemblages of other species. Regionally designated geodiversity sites. Regionally important assemblages of other species.
Local	A breeding population of a species or a viable area of a habitat that is listed in a Local Biodiversity Action Plan because of its rarity in the locality. A breeding population of a species on the Scottish Biodiversity List has been identified by the local authority as being a material consideration in terms of its planning process. All breeding populations of an EPS, Schedule 1 and/or 5 species that have not been captured in higher categories above.

Level of Nature Conservation Value	Examples of Receptors
	Assemblages of other species that are of importance in the context of the local authority area.
Site	Other species and habitats which are, in the opinion of the assessor, of note and for which mitigation measures could be recommended as a good practice measure.

Criteria for Assessment of Impacts

11.5.10 An understanding of how ecological features will respond to the Proposed Development is required to determine the magnitude of any likely impacts which may arise through construction or operational phases. It is only necessary to describe in detail the effects which are likely to be significant and impacts/effects which are unlikely to occur, or if they did happen would unlikely be significant and can be scoped out (CIEEM, 2018 as amended).

Beneficial or Adverse Effects

11.5.11 Beneficial and adverse effects are determined whether the change is in accordance with the following nature conservation policy and objectives:

Beneficial – a change which improved the quality of the environment, for example, increasing species diversity or extending / improving habitat extent. This can also include reducing the rate of existing environmental decline; and

Adverse – a change which results in a reduction of the quality of the environment, for example, habitat destruction, habitat fragmentation, loss of species or pollution events.

Extent

11.5.12 The extent of an impact refers to the geographical area over which the impact may occur over typically representative conditions. For example, increased sediment run-off in watercourses.

Frequency and Timing

11.5.13 The resulting effect of an impact is influenced by the number of times an activity occurs. For example, a vehicle driving across sensitive habitat; one vehicle may have a small irreversible impact (habitat may recover), however, frequent vehicle passes may significantly degrade the habitat to the point where it may not recover and be permanently lost.

Reversibility

11.5.14 An impact from which recovery is not possible within a reasonable timescale or there is no chance of action to implement successful mitigation, the impact is classed as irreversible. An impact from which spontaneous recovery or with which recovery is possible through successful mitigation is classed as reversible. It should be noted that in some cases the same activity can cause impacts which are both irreversible and reversible.

Duration

11.5.15 CIEEM, 2018 as amended, states that duration is defined in the relative context of ecological traits, such as the lifecycle of a species. The duration of an activity may differ from the duration of the resulting effect caused by the activity. Table [4.4] defines the timescales used within this Chapter and Ecological Impact Assessment.

Table [11.4] Duration of Effects

Duration	Definition
Permanent	Effects continuing indefinitely beyond the span of one human generation (30+ years), except where there is likely to be substantial improvement after this period in which case the Long Term maybe more applicable.
Long term	Between 15 years up to (and including) 30 years.
Medium term	Between 5 years up to (but not including) 15 years.
Short term	< 5 years.
Temporary	No short-term effect.

Sensitivity

11.5.16 The sensitivity of an ecological receptor to a particular impact should also be considered as well as the zone of influence. Sensitivity criteria is variable across the taxonomic groups and behavioural sensitivity can also vary across individuals of the same species. Sensitivity can also be dependent on species' activity, for example, species are more likely to be susceptible to disturbance during the spawning seasons. As such, professional judgement is used when assigning sensitivity to an ecological receptor. Sensitivity is determined according to the species' behaviour, outlined using the criteria in Table 11.5.

Table 11.5 Levels of Sensitivity

Level of Sensitivity	Definition
High	Species in remote areas, away from human disturbance which would result in a long-lasting reaction to a disturbance event. Habitats which are considered to have a slow recovery time and could not re-establish quickly.
Medium	Species which are tolerant to human activity which result in a short-term reaction to a disturbance event. Habitats which are considered to have a moderate recovery time.
Low	Species which are regularly subject to human disturbance which result in a brief reaction to a disturbance event. Habitats which are considered to have a quick recovery time and could readily established.

Magnitude

11.5.17 The magnitude of an impact refers to the size, intensity, or volume of and should be quantified where possible in absolute or relative terms. For example, exact areas of habitat loss or percentage of species population decline (CIEEM, 2018 as amended). Table 11.6 defines the four levels of magnitude used in this assessment; these are generally considered to be adverse unless stated otherwise.

Table 11.6 Criteria for describing the magnitude of impacts on IEFs

Magnitude of Impact	Description
High	High impacts may include those that result in large-scale, permanent (or at least the lifetime of the Proposed Development) changes in an IEF, and likely to change its ecological integrity. These impacts are likely to result in overall changes in the conservation status of a species population or habitat type at the location(s) or geographical scale under consideration.
Medium	Medium impacts may include moderate-scale, permanent (with respect to the lifetime of the Proposed Development) changes in an IEF, or larger-scale temporary changes, but the integrity of the feature is not affected. This may mean that there are temporary changes in the conservation status of a species-population or habitat type at the location(s) or geographical scale under consideration, but these are unlikely to be irreversible or long-term.
Low	Low impacts may include those that are small in magnitude, have medium-scale temporary changes, and where integrity is not affected. These impacts are unlikely to result in overall changes in the conservation status of a species population or habitat type at the location(s) under consideration, but it does not exclude the possibility that mitigation or compensation will be required.
Negligible	There is no perceptible change in the ecological feature

Significance of Effects

11.5.18 The combined assessment of both the sensitivity of the receptor (Nature Conservation Value) and the magnitude of potential impact determines whether an effect is likely to be significant (Table 11.7). Table 11.7 describes the significance of each effect. Effects categorised as **Moderate or Major** significance are evaluated as **'significant'** under EIA Regulations, whilst those categorised as Minor or Not Significant significance are evaluated as 'not significant' and not discussed further in this Chapter.

Table 11.7 Significance of Effects Matrix

		Magnitude of Potential Impact			
		High	Medium	Low	Negligible
Nature Conservation Value	International	Major	Major	Moderate	Minor
	National (Scotland)	Major	Major	Moderate	Minor
	Council (Highlands)	Major	Moderate	Minor	Not Significant
	Local (Loch Laggan Catchment)	Minor	Minor	Minor	Not Significant
	Low (Site)	Not Significant	Not Significant	Not Significant	Not Significant

11.5.19 Where potential effects are identified as being significant, the mitigation hierarchy (avoid, mitigate, compensate, enhance) is applied to mitigate for these significant effects. Significance criteria is defined in Table 11.8.

Table 11.8 Significance Criteria

Significance Criteria	Definition
Major	Significant effect. The effect is likely to result in a permanent / long term and a highly significant effect on the integrity of a nature conservation feature of particularly high value (National / International). Usually only applied to adverse effects.
Moderate	Significant effect. The effect is likely to result in a medium-term with a high/medium extent. These beneficial or adverse effects are considered to be critical factors and are likely to be material in the decision-making process.
Low	No significant effect. Likely effect the feature at an insignificant level by virtue of its limited duration and/or extent, but there would probably be no effect on its integrity. May become a decision-making issue if leading to an increase in the overall adverse effect on a particular resource or receptor.
Negligible	Negligible effect. This is not a significant effect.

Assumptions and Limitations

11.5.20 Moderate survey limitations were encountered when surveying for the Proposed Development but are not considered to effect the outcome of this EIAR.

11.5.21 Surveys undertaken are representative of the conditions present during the duration of the survey, due to this, definitive findings are not always possible. It is feasible that species may use the site seasonally and/or be in populations too low for detection and are therefore not represented in the survey findings or presence is under/overexaggerated. It is considered that any such recording is unlikely to alter the conclusions gained in this chapter and therefore any under recording is likely to reflect a minor limitation in this EIAR.

11.5.22 It is assumed that Arctic charr are present within Loch Leamhain due to the presence of juvenile Arctic charr (fry) in the connected Allt Loch a'Bhealaich Leamhain outflow. Presence of Arctic charr is likely a result of spawning in the outflow or fry washing downstream, it is considered unlikely that fry have moved upstream from the Allt Cam/Loch Pattack. The results of eDNA testing were inconclusive, therefore, based on the Precautionary Principle it is considered that Arctic charr are present for the purposes of the EIAR.

11.5.23 It is assumed that Arctic charr are present within Loch Earba West due to the presence of juvenile Arctic charr (fry) in two connected tributaries to Loch Earba West (Allt Coire Pitridh and the Moy Burn). The population of Arctic charr is considered to be in an unfavourable condition as their presence was undetectable via gill netting surveys.

11.5.24 Arctic charr fry recorded in the tributaries are considered for the purpose of this report to be the progeny of stream spawning of adults accessing streams from the lochs. However, specific spawning surveys for Arctic charr were not conducted in these waterbodies (where they are most commonly recorded spawning). Consequently, it is assumed under the Precautionary Principle that Arctic charr spawn in both riverine and loch habitat.

11.5.25 It is considered that Freshwater Pearl Mussels (*Margaritifera margaritifera*) are not present within the Proposed Development in light of consultation with NatureScot.

11.5.26 No data exists for ferox trout, *Salmo trutta*, on Loch Earba or Loch Leamhain and surveys findings did not record the presence of any ferox trout. Presence of Arctic charr as a common food source does not signify the presence of ferox trout, despite sympatry in other waterbodies. Additionally, no ferox trout were detected during electrofishing or gillnetting. Consequently, it is concluded that ferox trout are not present in any waterbody assessed based on the data currently available.

11.5.27 For the purpose of this assessment and based on a review of current and historic data we have concluded that there are no migratory fish (Atlantic salmon, *Salmo salar*; Sea trout, *Salmo trutta*; migratory lamprey, *Petromyzon marinus* and *Lampetra fluviatilus*; European eel, *Anguilla anguilla*) present on Site. This is due to the presence of two impassable barriers downstream of the Site and additionally the prolonged stretch of the Allt Labrach which is regularly dry due to existing hydropower infrastructure. Additionally, none of the aforementioned species were detected during both electrofishing and gillnetting. Therefore, brown trout refers to resident, non-anadromous life history strategies only.

11.5.28 Where species specific information regarding species tolerances of environmental conditions (e.g., temperature, noise and/or blasting) is unavailable, tolerance thresholds of similar species may be used (e.g. Atlantic salmon as a proxy for brown trout and/or Arctic charr).

11.5.29 Fully-quantitative population assessments were not conducted at all sites due to areas of deep/fast moving water unsuitable for safe wading, semi-quantitative assessments were undertaken at such locations. Fully quantitative population data could not be separated into individual groups for brown trout, due to the presence of both trout and charr fry at the same sites, limitations in accurately identifying between Arctic charr and brown trout fry accurately in the field at the time of survey (July), was considered a limitation for the purpose of the report.

11.6 Baseline Conditions

Existing Baseline

Designated Sites

11.6.1 The locations of sites designated for nature conservation interest within the relevant study area are shown in **Figures 11.1 and 11.2**. Sites designated for geological interest were excluded, and sites relating to ornithology are considered in **Chapter 10: Ornithology**.

11.6.2 Details of the international nature conservation designations within 10 km of the Site, international and national nature conservation designations, and other nature conservation designations within 2 km of the Site, relating to only aquatic ecological interest, are provided as an Appendix. All other nature conservation designations for Terrestrial Ecology and Ornithology are referenced in **Chapters 8, 9 and 10** of this EIAR.

11.6.3 There are no statutory designated sites, noted for aquatic qualifying interests, with connectivity to any habitats within this proposed development site. The reason for this is that there are two migratory barriers along the rivers leading to the Proposed Development and therefore no connectivity pathways exist.

Subsequently a shadow Habitat Regulation Assessment has not be prepared for the proposed development.

11.6.4 There are no non-statutory sites of nature conservation value e.g. local wildlife sites or Scottish Wildlife Trust reserves within 2 km of the proposed development site boundary.

11.6.5 There are three internationally designated sites within 10 km of the site boundary (**Table 11.9**) including: River Spey SAC (four relevant designations); Ben Alder and Aonach Beag SAC (one relevant designation); and Creag Meagaidh SAC (one relevant designation).

11.6.6 There is one nationally designated site within 10 km of the site boundary (Table 11.9), the River Spey SSSI (two relevant designations).

Table 11.9 Designated Sites within 10 km of Proposed Development

Designated Site	Relevant Qualifying Features	Last Assessed Condition	Negative Pressures	Location relative to Proposed Development
River Spey SAC (International)	Atlantic salmon	Unfavourable Recovering (2011)	Agricultural operations, invasive species, water management	Different catchment
	Freshwater Pearl Mussel	Unfavourable Declining (2014)	Extraction, invasive species, water quality, wildlife crime	
	Otter	Favourable Maintained (2011)	Other, over grazing	
	Sea Lamprey	Favourable Maintained (2011)	None	
Ben Alder and Aonach Beag SAC (International)	High-altitude plant communities associated with areas of water seepage	Unfavourable No Change (2009)	Trampling	Hydrologically connected to the Allt Cam, downstream of Loch Leamhain.
Creag Meagaidh SAC (International)	Clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels	Favourable Maintained (2010)	None	Hydrologically connected to Loch Laggan (downstream of Loch Earba. Unlikely to be impacted.

Designated Site	Relevant Qualifying Features	Last Assessed Condition	Negative Pressures	Location relative to Proposed Development
River Spey SSSI (National)	Atlantic salmon Freshwater Pearl Mussel	Unfavourable Recovering (2004) Unfavourable Declining (2004)	Invasive species Extraction, Invasive species, water quality, wildlife crime	Different catchment

11.6.7 The River Spey SAC and SSSI are not hydrologically connected to the Proposed Development (within another catchment) and are therefore scoped out of further assessment.

11.6.8 The Creag Meagaidh SAC is hydrologically connected to the Proposed Development, however, the designated area is limited to tributaries in the upper catchment of Loch Laggan, and therefore existing flows are likely to prevent any adverse impacts to the SAC.

11.6.9 The Ben Alder and Aonach Beag SAC is hydrologically connected to Loch Leamhain via the outflow of the Allt Loch a' Bhealaich Leamhain connected to the Allt Cam and Loch Pattack. Due to hydrological connectivity NatureScot has requested a shadow HRA be compiled to address any potential impacts as a result of the Proposed Development, this is not considered further in this EIAR.

Field Survey Results

11.6.10 The Ecological Impact Assessment (EcIA) presented here has been informed by a series of technical field surveys, as described in, **Appendix 11.1**: Loch Earba Baseline Aquatic Surveys. In summary, the surveys included:

Fish Habitat Assessment

11.6.11 A total of five habitat types were identified within the area surveyed covering 10,822 m. Results are presented in **Table 11.10**, and detail identified Productive (high), Productive (moderate), Productive (low), Lamprey, and Not Suitable habitat; no bedrock channels were present. Productive habitat comprised the greatest habitat loss as a result of the Proposed Development at 2,224.7 m (82.6% of total loss).

Table 11.10 Summary of Fish Habitat Loss

Habitat Type	Total Length (m)	Percentage of Total Habitat Assessed (%)	Length Lost (m)
Productive (high)	267	2.47	267
Productive (moderate)	7,538	69.65	1,459.4
Productive (low)	2,131	19.69	498.3
Bedrock	0	0	0
Lamprey	25	0.23	0
Not Suitable	861	7.95	496.9
Total:	10,822		2,694.6

11.6.12 Loch margin substrate, including rocky substrate and sand, is consistent with oligotrophic status of Loch Earba (West and East), and Loch Leamhain. Existing hydropower infrastructure has likely resulted in existing deterioration of marginal habitat due to water level fluctuations.

11.6.13 A total of 11 obstacles were identified in surveyed areas, these likely limit the extent to which fish can utilise watercourse for feeding and spawning. A total of five Optimal spawning areas (for salmonids) were identified throughout the surveyed areas were identified for their spawning potential, all are predicted to be lost as a result of Proposed Development infrastructure.

Fish Population Surveys

11.6.14 A total of three species were identified during fish population surveys: brown trout; Arctic charr; and Eurasian minnows.

11.6.15 Arctic charr were determined to be in unfavourable condition status within Loch Earba East and West based on the data available for this report. Four individuals were identified during gillnetting surveys (Loch Earba East) within deepest water identified (21 m) at a density of 0.07 ha^{-1} (favourable status is 37 ha^{-1} [20]). No individuals were identified within gillnets in Loch Earba West, however, presence of juveniles but no adults in adjoining tributaries is indicative of a breeding population of adults in the Loch. As no adults were detected via the gillnets it is considered that they are present in densities too low for detection, and thus in unfavourable condition. Gillnetting could not be undertaken in Loch Leamhain due to site-specific constraints, however, the presence of Arctic charr fry in the Allt Loch a' Bhealaich Leamhain strongly suggests their presence in Loch Leamhain .

11.6.16 Brown trout were widespread throughout the site. Eurasian minnow were limited to Loch Earba and adjoining tributaries and were not present in Loch Leamhain and

[20] Bean, C. W. (2003). A standardised survey and monitoring protocol for the assessment of Arctic charr, *Salvelinus alpinus* L., populations in the UK. Joint Nature Conservation Committee, Peterborough.

are considered an invasive non-native species in Loch Leamhain for the purposes of the EIAR.

Macroinvertebrate Surveys

11.6.17 Macroinvertebrate results were highly variable. Within Loch Earba East and adjoining tributaries surveys indicated high water quality with high BMWP (118 and 82), PSI (77.27 and 95.00) and EPSI (89.78 and 100.00) scores. Within Loch Earba West and adjoining tributaries surveys indicated high BMWP (75), PSI (100) and EPSI (100) scores but low CCI (6.00) scores. Loch Leamhain scored moderately on BMWP, PSI and EPSI but indicated Fairly high conservation value on the CCI index throughout both Spring and Summer sampling. Several species of nature conservation value were identified including: the Arctic-alpine pea mussel (*Pisidium conventus*) which three records in Scotland which post 1997. The Arctic-alpine pea mussel is as the name suggests an arctic relic species, typically found where temperatures are low or in deeper parts of lochs or where it is deeply shaded. This is a species which has been under recorded due to the nature of the habitats it is found within. Davis's river diver (*Oreodytes davisii*) which is classified as near threatened and declined by 31% in the UK since 1989 and is particularly sensitive to the frequency of water inundation and its effect on habitat suitability as well as nutrient enrichment.

Macrophyte Surveys

11.6.18 The Macrophyte survey indicated the presence of 37 species in all three waterbodies surveyed. All species identified were designated as 'Least concern' for conservation value. Submergent communities displayed smaller species variation, when compared to emergent communities, with 17 species identified compared to 22. Loch Leamhain displayed little overall assemblage variation with 4 species identified. Complete species lists are available in the Technical Appendix Report.

11.6.19 No invasive non-native species were present in any waterbody surveyed.

***In-situ* Water Quality**

11.6.20 Water Quality results indicated high ambient water quality. No parameters observed were indicative of underlying pollution. All parameters conformed to standards suitable to support salmonids (of parameters available).

Desk Study

11.6.21 Results of the desk study are summarised in **Table 11.11**.

Table 11.11 Summary of Desk Study

Habitats / Species / Constraints	Source (s)	Relevant Data
Loch Earba	UK Lakes Portal	Loch Earba (East) (Water Body ID 21751) is a large freshwater lake located in the Highlands, Scotland. It is generally shallow with low alkalinity and is situated at mid altitude. It is 56 ha, with a mean depth of 9.5 m and a maximum depth of 21.0 m. It sits at an elevation of 347 m AOD.

Habitats / Species / Constraints	Source (s)	Relevant Data
		Loch Earba (West) (Water Body ID 21823) is a large freshwater lake located in the Highlands, Scotland. It is generally shallow with low alkalinity and is situated at mid altitude. It is 105 ha, with a mean depth of 10.9 m and a maximum depth of 24.7 m. It sits at an elevation of 352 m AOD.
	SEPA River and Loch Classifications	Loch Earba (East) (Lake ID: 100200) is located in the River Lochy catchment. The water is considered to be in 'good ecological' overall status. The waterbody is designated as 'heavily modified' due to water storage alterations for hydroelectricity generation. Loch Earba (West) (Lake ID: 100204) is located in the River Lochy catchment. The water is considered to be in 'good ecological' overall status. The waterbody is designated as 'heavily modified' due to water storage alterations for hydroelectricity generation.
Loch Leamhain	UK Lakes Portal	Loch Leamhain (Water Body ID: 21949) is a small freshwater lake located in the Highlands, Scotland. It is generally shallow with medium alkalinity and is situated at mid altitude. It is 33 ha, with a mean depth of 7.0 m (maximum depth 32 m). It sits at an elevation of 636 m AOD.
	SEPA River and Loch Classifications	N/A
Watercourses	SEPA River and Loch Classifications	Mid Lochan Loch Earba (ID: 203070) is a river in the River Lochy catchment approximately 0.9 km in length. The river is considered to be in 'good ecological' overall status. The Allt Coire Pitridh (ID: 20371) is a river in the River Lochy catchment approximately 3.6 km in length. The river is considered to be in 'good ecological' overall status. The Allt Labrach (ID: 20369) is a river in the River Lochy catchment approximately 2.0 km in length. The river is considered has been designated as heavily modified water body on account of physical alterations that cannot be rectified without significant impacts on water storage for hydroelectricity generation. The river is considered to be in 'bad ecological' overall status.
Obstacles to fish migration	Scotland's Environment Web	Two barriers were identified with relevance to the Proposed Development. Barrier 1 (ID: 20658) is an impassable artificial barrier located at the outflow of Loch Earba East. This prevents the passage of aquatic features between Loch Earba and Loch Laggan. Barrier 2 (ID: 3266) is an impassable artificial barrier located at the downstream extent of the River Spean. This prevents the passage of aquatic features between Loch Laggan and the downstream catchment.

Habitats / Species / Constraints	Source (s)	Relevant Data
Invasive Non-Native Species	NBN Atlas	No invasive aquatic features were identified.
Arctic charr	Hardie, 1940[21]	Information on Arctic charr in Loch Earba and Loch Leamhain. One occurrence of Arctic charr being caught c. 1940 in Loch Earba East. Previous gillnetting effort did not detect populations[22].
Macroinvertebrates	NBN Atlas	No recent information on species presence and/or abundance was available within the Zone of Influence. Unverified and unpublished resources were made available but were used for reference only and not incorporated into the assessment.
Designated sites/features	NatureScot Sitelink	No designated sites have been taken forward for assessment.

Summary of IEFs are provided in **Table 11.12.**

Table 11.12 Summary of IEFs

Feature	Conservation Status	Evaluation within Study Area	Importance
Arctic charr	UKBAP, Vulnerable, National Importance	Present throughout Loch Earba (East and West), Loch Leamhain, Moy Burn, Allt Loch a' Bhealaich Leamhain and Allt Coire Pitridh/ Allt Coire a' Chlachair. Juveniles present in watercourses only (indicative of river spawning) and adults present only in waterbodies.	National
Brown trout	UKBAP	Widespread throughout Loch Earba (East and West Basin), Loch Leamhain, Moy Burn, Allt Loch a' Bhealaich Leamhain and Allt Coire Pitridh/ Allt Coire a' Chlachair.	Local
Eurasian minnow	Common	Widespread throughout Loch Earba (East and West Basin) and adjoining tributaries.	Less than Local

[21] Hardie, R. P. (1940). Ferox and charr in the lochs of Scotland. Edinburgh, UK: Oliver and Boyd. 219 pp.

[22] McMorrine, E. (N/A). An Investigation into the Impacts of the Lochaber Hydrological Scheme upon the Native Fish Biodiversity of Loch Laggan.

Feature	Conservation Status	Evaluation within Study Area	Importance
Watercourse fish habitat	-	Supports nationally important IEF (juvenile Arctic charr) populations and, spawning areas.	National
Waterbody fish habitat	-	Supports nationally important IEF (Arctic charr) populations and likely spawning areas.	National
Macrophyte	Least Concern	Distributed throughout Loch Earba (East and West Basin) and present in low densities in Loch Leamhain.	Local
Macroinvertebrates	Nationally Rare (*Psidium conventus*)	Widespread throughout Loch Earba (East and West Basin), Loch Leamhain and adjoining tributaries.	National (*Psidium conventus*) and Local (all other species)

Future Baseline

11.6.22 This section details what the future baseline conditions of the site would be like without the Proposed Development being consented; and presents an objective assessment to explore whether mitigation and enhancement measures within the Proposed Development could address the future baseline condition, particularly if the future baseline could be negatively impacted in the near future.

11.6.23 Trends in population declines should be considered when determining a future baseline. Arctic charr populations are considered to be likely to continue to decline in response to climate change given sensitivities to increases in water temperature and the location of Scotland at the southern extremity of its global range[23].

11.6.24 Limited existing data on fish population size exists outwith baseline surveys conducted in relation to the Proposed Development. Unlike catchments where fishing is more prevalent, limited historical rod data is available to assess long-term population level changes. Sporadic rod fishing has been undertaken historically throughout the Ardverikie Estate but no rod catch data is available; it should be noted that there were no Arctic charr records.

11.6.25 Climate change has impacts on aquatic ecosystems. The ten warmest years on record in Scotland have all occurred since 1997. The average temperature in the last decade (2010-2019) was approximately 0.7 °C warmer than the 1961-1990 average. In recent decades, there has been an increase in rainfall across Scotland, with an increasing proportion due to heavy rainfall events. Average annual rainfall in the last decade (2010-2019) was 9% wetter than the 1961-1990 average[24].

[23] Nunn, A. D., Ainsworth, R. F., Walton, S., Bean, C. W., Hatton-Ellis, T. W., Brown, A., Evans, R. Atterborne, A., Ottewell, D. and Noble, R. A. A. (2023). Extinction risks and threats facing the freshwater fishes of Britain. *Aquatic Conservation: Marine and Freshwater Ecosystems.* 1-7.

[24] Scotland's Environment (2021) How has Scotland's climate changed? [Online] Available at: Changing climate | Scotland's environment web

11.6.26 A report published by Scotland's Centre of Expertise for Waters (CREW) showed that between 2015 and 2019, 97% of monitored Scottish lochs and reservoirs increased in temperature. While most warmed by up to 1.0 °C per year over this period, 9% increased by more than that – some by up to 1.3 °C per year. These changes increase the risk of harmful algal blooms developing, which could impact on ecological features including fish and their habitats. Algal blooms have been recorded previously on Loch Earba by SEPA in 2022 showing an increased likeliness of future events. It is expected that waters in the south and east of Scotland are expected to warm the most at first, however this climate-related impact will reach all parts of the country by 2040[25].

11.6.27 Predicted effects of climate change include average temperatures increasing across all seasons, typical summers will be warmer and drier, typical winters will be milder and wetter and intense, heavy rainfall events will increase in both winter and summer.

11.6.28 These effects have impacts on fish including reduction in dissolved oxygen levels and reduced river flow and loch levels in summer for fish. In winter there will be a greater risk off egg washout in watercourses during heavy rainfall events. Temperature fluctuations will also have impacts on egg incubation, hatch times and may alter seasonal behaviour of fish.

11.6.29 Utilising renewable energy sources, such as pumped storage hydroschemes, has the potential to slow and/or reduce the negative water temperature changes associated with climate change. Renewable energy sources limit greenhouse gas emissions associated with non-renewable energy sources, e.g. carbon dioxide with coal fired power stations, that absorbs and radiates heat warming the atmosphere. This will aid in mitigating against population declines of a species, such as Arctic charr reliant on colder environments, by reducing temperature increases. This has the potential to provide a beneficial effect on the wider Arctic charr population.

11.7 Mitigation by Design & Embedded Mitigation

11.7.1 The Proposed Development has been subject to a number of design iterations based on initial data provided through baseline studies. The purpose of the identification of constraints at an early stages of the scheme design is to reduce environmental effects (**Chapter 3: Consideration of Alternatives and Design Evolution**) in relation to aquatic IEFs. The following design changes have been incorporated to avoid or minimise negative effects:

11.7.2 The approach velocity of water across the intake screen during abstraction / pumping mode will be <0.3 m/s. This will ensure that most adult fish species will be able to overcome the effect of entrainment / impingement at the screens.

11.7.3 Appropriately designed vertical bar screens of maximum 12.5 mm aperture to cover the intake/outlet will be installed to prevent fish from entering the underground waterway system at Loch Earba and Loch Leamhain. This will prevent the risk of fish entrainment, injury and mortality, of transfer of individuals

[25] Linda, M., Philip, T., Iain, D. M., Gunn, S. J., Thackeray, L. R., Carvalho, P. H., Mairéad, C., Anne, J. D., Grant, A., Nash, G., Robinson, E. and Spears, B. M. (2022). Assessing climate change impacts on the water quality of Scottish standing waters. CRW2020_01. Scotland's Centre of Expertise for Waters (CREW). [Online] Available at: [Assessing climate change impacts on the water quality of Scottish standing waters] | CREW | Scotland's Centre of Expertise for Waters

between waterbodies. It is possible that smaller fish (i.e. juvenile brown trout, juvenile Arctic charr or European minnows) may be able to pass through the 12.5 mm mesh aperture, however, aperture to prevent all life stages (e.g. 1 mm) will result in continual foliage / debris build up and increase velocities across the screen, likely increasing the overall impact on fish.

11.7.4 Embedded mitigation for spawning habitat losses will include the provision of sections of optimal spawning substrate on diversion channels (Loch Earba) and floating spawning substrates (loch Leamhain and Loch Earba) to mitigate against losses elsewhere in the catchment and enhance overall spawning opportunities for fishes.

11.8 Potential Significant Effects

11.8.1 This section considers the potential impacts and associated effect significance of the construction, and operation of the Proposed Development based on the typical activities described in **Chapter 2: the Proposed Development**. As the project is predicted to have an indefinite lifespan, decommissioning impacts are not covered by this assessment but if eventually this was to occur it is likely that impacts would need to be assessed and it is considered likely that the decommissioning impacts would be of the same magnitude and significance as the construction stage effects.

Construction Effects

The below section details the potential effects, assuming that the good practice mitigation measures detailed in paragraphs 11.7 above are implemented on each IEF or feature in turn. The impact effects have been assessed only for IEFs of Local or higher nature conservation value or species protected by wildlife legislation. The construction phase is predicted to last three years, consequently all duration of effects are predicted to be short term (< 5 years) or temporary. The impacts during the construction phase are detailed below:

Habitat loss and fragmentation

11.8.2 Brown trout populations in Loch Earba, Loch Leamhain, Allt Loch a' Bhealaich Leamhain, Allt Coire Pitridh, Allt Coire a' Chlachair, Allt Labhrach and Allt Cam have the potential to be impacted by the dam construction works. The construction of the dams will require dry channels meaning watercourses will be diverted / over pumped during construction. Brown trout populations may be affected by these operations, causing displacement, mortality or the temporary loss of habitat relating to the construction footprint. No impact on spawning areas are impacted during the construction phase for watercourse dwelling trout, however, brown trout within Loch Earba and Loch Leamhain will be isolated from potential spawning areas. The significance of this effect prior to mitigation is considered to be a medium magnitude impact on a species of local nature conservation value and therefore **Minor (Not Significant) overall**; despite the non-significant impact, mitigation is proposed to minimise the risk to brown trout. For permanent loss of habitat as a result of dam footprint see Operational effects.

11.8.3 Dam construction works within Loch Leamhain is considered unlikely to influence loch populations due to partial de-watering, however, Arctic charr and brown trout present in Allt Loch a' Bhealaich may experience increased dust and pollution run off (e.g. suspended solids and/or turbidity). The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr and **Minor**

(Not Significant) for brown trout respectively. The impacts of de-watering are considered within Section 11.8.11-18.

11.8.4 Juvenile Arctic charr and brown trout also have the potential to be impacted by construction works through the obstruction of passage from watercourse to loch habitats and the fragmentation of habitat in both Loch Leamhain and Loch Earba. This may cause an increased competition for resources and territories as mature individuals that would typically migrate to waterbodies are unable to do so. The significance of this effect prior to mitigation is considered to be **Major (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.5 During construction of the dams (Section 11.8.2) movement of resident brown trout will be restricted between watercourses and loch margins in Loch Earba West and Loch Leamhain. The significance of this effect prior to mitigation is considered to be **Minor (Not Significant).** No movement can occur given current existing hydropower infrastructure between Loch Earba East and Allt Labrach, therefore additional effects are unlikely to occur.

11.8.6 During construction of the dams, movement of river spawning Arctic charr and brown trout on the Allt Coire Pitridh may be obstructed and/or affected by construction works. Consequently spawning success may be reduced and/or unsuccessful if fish are forced to spawn in sub-optimal or unsuitable areas further downstream or in loch margins. The significance of this effect prior to mitigation is considered to be **Major (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.7 The existing watercourse from Loch Earba West feeding the reservoir will be culverted during construction and operational periods to maintain existing water levels. The installation of this culvert will need to take place in a dry channel meaning that the watercourse will be diverted / over pumped during construction. Current drainage channels provide low quality habitat and are unlikely to support fish, the significance of this effect prior to mitigation is considered **Minor (Not Significant)** for brown trout.

Water quality

11.8.8 All fish species within the site and zone of influence have the potential to be impacted by water quality changes as a result of dust, run off, chemical/fuel spills and/or concrete washout from construction works without mitigation. Water quality parameters likely to be affected include, but are not limited to, turbidity, total dissolved solids, total suspended solids, pH, conductivity and temperature, the significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.9 Areas surrounding both waterbodies and watercourses (e.g. dam footprint areas) are particularly prone to dust pollution as a result of construction works being situated close to borrow pit locations with associated increased traffic and crushing of aggregates concentrating dust on Site. This has the potential to deteriorate water quality (as in Section 11.8.8), notably with increased suspended solids. Without mitigation this has the potential to impact all aquatic IEFs. The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.10 All fish within Loch Leamhain, Arctic charr (assumed under the precautionary principle) and brown trout have the potential to be impacted by the temporary partial dewatering of Loch Leamhain. Whilst this has potential benefits for silt and

drainage management during the construction period, any pollution incidents will be contained within a smaller volume of water with the receptive waterbody having a lower buffering capacity. The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.11 Macroinvertebrates, notably *P. conventus*, has the potential to be impacted by changes in water quality as a result of construction works around Loch Leamhain. *P. conventus* is likely sensitive to changes in water quality parameters due to its filter feeding nature and limited ability to move away from unsuitable habitat. Increases in suspended siltation and/or silt accumulating on the watercourse bed may injure *P. conventus* via oxygen deprivation and may result in mortalities. The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for *P. conventus*.

Partial Dewatering of Loch Leamhain

11.8.12 Partial dewatering of Loch Leamhain will lower the average water level to 610 m from its current 636 m level and in doing so reduce the volume of water available for fish to utilise. This will increase the density of fish (as the same number will be concentrated within a smaller volume) and may result in increased competition for food and territory resulting in injury, weakened body condition and/or mortality of individuals. This may also increase inter-species interactions of Arctic charr and brown trout where they may come into increased competition for resources. The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.13 Reduction of the water volume of Loch Leamhain during summer temperatures has the potential to increase water temperatures. Arctic charr are known temperature sensitive receptors (at 21°C mortality is 60% and is considered supra-optimal for growth[26]), consequently prolonged periods of warm air may increase ambient water temperature. Additionally, Arctic charr are reliant on temperature cue for spawning, changes in temperature may alter behaviour resulting in decreased egg viability. Due to altitude of the waterbody any temperature variation is likely to be less extreme, consequently, the significance of effect is considered **Moderate (Significant)** for Arctic charr. The upper lethal limit of 27°C for brown trout[27] is unlikely to be reached and therefore increasing temperatures due to de-watering has been considered to have no likely significant effect.

11.8.14 Reduction of the water volume of Loch Leamhain during winter temperatures has the potential to decrease water temperatures, particularly due to the high altitude of the loch. This may increase the risk of prolonged colder water temperatures and the formation of ice. Arctic charr are resilient to low temperatures, however, brown trout growth ceases below 3.5°C[27] and consequently may be more vulnerable; significance of effect is considered **Minor (Not Significant)** for brown trout.

11.8.15 Partial dewatering of Loch Leamhain will isolate river spawning Arctic charr and brown trout populations from the Allt Loch a' Bhealaich Leamhain, and juvenile fish

[26] Beuvard, C., Imsland, A. K. D. and Thorarensen, H. (2022). The effect of temperature on growth performance and aerobic metabolic scope in Arctic charr, *Salvelinus alpinus* (L.). *Journal of Thermal Biology.* 104.

[27] Environment Agency. (2008). The thermal biology of brown trout and Atlantic salmon. [Online] Available at: https://assets.publishing.service.gov.uk/media/5a757e3040f0b6397f35edaa/scho1008boue-e-e.pdf

in the watercourse will not be able to return to Loch Leamhain. Although a construction effect, permanent obstruction will result from Operational effects and is considered under Section 11.8.43. During the construction phase water levels of Loch Leamhain will remain constant, providing marginal loch spawning areas in the newly established littoral zone. Due to a lack of information on spawning preferences of Arctic charr specific to Loch Leamhain it is considered that the fish utilise both riverine and marginal habitats. Consequently spawning will not be disrupted for a proportion of the Arctic charr; riverine spawning Arctic charr may also utilise marginal areas in the absence of riverine habitat availability. The significance of effect is considered **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.16 Partial dewatering of Loch Leamhain will lower the average water level considerably resulting in the prolonged aerial exposure of the littoral zone. This is likely to have a temporary, high magnitude effect on macrophyte and macroinvertebrate abundance and distribution. This high magnitude effect is predicted to be permanent during operation.

11.8.17 Macrophytes are unlikely to survive prolonged aerial exposure without frequent submergence. Macrophyte communities in Loch Leamhain are not considered of conservation value with the taxa categorised as 'Least concern', therefore significance of effect is considered **Minor (Not Significant).**

11.8.18 The macrophytes in the littoral zone are likely to establish in the new, lowered littoral zone at lower water levels, however, dewatering is a temporary measure and operational water level fluctuations are predicted to prevent this.

11.8.19 Macroinvertebrates in inflowing and outflowing watercourses are unlikely to be affected by dewatering as water volume will be maintained in both cases. Macroinvertebrates within the littoral zone of Loch Leamhain are likely to be affected given the extent of water drawdown, approximately 10 - 20 m (location dependent). The majority of macroinvertebrates are unable to track receding water levels and are predicted to become stranded within the drawdown zone where mortality and/or predation is likely to occur. No macroinvertebrate IEFs were identified within Loch Leamhain (only outflow) consequently significance of effect is considered to be **Minor (Not Significant).**

Quarrying

11.8.20 Aggregate for the dam would be quarried from borrow pits within the reservoir drawdown footprint. This will cause no loss of aquatic habitat and could provide enhancement opportunities (see Section 11.9). Surface run-off of dust and pollutants has the potential to impact water quality (refer to paragraphs 11.8.8 - 11.8.10).

11.8.21 Increased traffic and works near the waterbodies and/or watercourses has the potential to increase dust and/ or surface run-off of suspended solids, however, reduced distance between aggregate source and dam reduces disturbance to other IEFs (see **Chapter 8: Terrestrial Ecology** and **Chapter 10: Ornithology**). The significance of this effect prior to mitigation is considered to be **Moderate (Significant)** for Arctic charr, **Minor (Not Significant)** for brown trout, **Minor (Not Significant)** for macrophytes and **Minor (Not Significant)** for macroinvertebrates.

Noise

11.8.22 Fish species in Loch Earba and Loch Leamhain within the vicinity of the works area have the potential to be impacted by construction works including: quarrying for borrow pits; dam construction; access track construction; and transportation of aggregate around the Site. Effects of noise associated with such works are considered to lead to negative behavioural responses (e.g. avoidance response), sub-lethal (e.g. shifts in hearing thresholds and/or disorientation) and/or lethal (e.g. mortality). The magnitude of impact is proportional to the sound level, distance between noise source and fish receptor and species of fish. In relation to noise, Atlantic salmon (*Salmo salar*) are known to detect low frequency acoustic stimuli below 380 Hz, this correlates to dominant frequencies produced from piling operations, 100 Hz to 2kHz[28]. The significance of this effect prior to mitigation is considered to be **Minor (Not Significant)** for brown trout. Brown trout are the primary IEF inhabiting the pelagic and littoral zones and therefore most sensitive to noise pollution. Arctic charr are not predicted to be affected as they inhabit deeper benthic habitats increasing the distance between noise and receptor. During spawning periods Arctic charr may migrate to shallower littoral zones to spawn in loch margins where they may come into contact with louder noise as a result of the construction. Exposure to noise is likely to be low in frequency and duration, and in volumes not sufficient to cause injury and/or mortality, therefore significance of effect is predicted to be **Minor (Not Significant)**.

11.8.23 Perception of noise for different species of fish and at different life stage is critical in determining extent of impact. For example, variation in noise perception is proportional to the distance between the swim bladder and the inner ear. In smaller species, or fish in younger life stages associated with smaller physical appearances, this distance is smaller resulting in more acute noise perception.

11.8.24 Cumulative noise from construction activity should not exceed 66 dB at its maximum (in Torgulbin), general cumulative noise on the estate is predicted to be 50 dB (see Chapter 18: Noise and Vibration).

11.8.25 Acoustic propagation modelling would be required to display the current and potential soundscape of the underwater environment in Loch Earba to determine the extent / distance to which noise travels laterally and horizontally within the water column, and the interaction of noise with environmental variables. This has not been conducted within this assessment.

11.8.26 Construction noise and vibration would be managed through a Construction Noise & Vibration Management Plan (CNVMP) which would be agreed prior to construction works.

Vibration

11.8.27 Piling is anticipated to be required during the construction of the powerhouse, but is primarily limited to terrestrial habitats and instream use will be kept to a minimum; effects are therefore expected to be minimal (if present). Vibratory piling (as suggested in Chapter 18: Noise and Vibration) has shown to have no obvious

[28] Scottish Government. (2016). Measurement of Hearing in the Atlantic salmon (Salmo salar). [Online] Available at: https://www.gov.scot/publications/measurement-hearing-atlantic-salmon-salmo-salar/#:~:text=Atlantic%20salmon%20are%20known%20to,et%20al.%2C%202015).

signs of trauma or startle responses in brown trout[29]. Equivalent vibratory studies are not available, however, it is anticipated that vibration will likely have a reduced effect on Arctic charr (when compared to brown trout) due to the species preference for deep water.

11.8.28 Blasting activities during construction have the potential to cause barotrauma (notably to swim bladders)[30]. Blasting guidelines established that blast induced pressures should not exceed 2.7 psi (lbs/in, 19 kPa) in the water and vibrations should not exceed 0.5 in/s (13 mm/s) in spawning gravels when fish or embryos are present. Mitigation measures proposed in the CNVMP would limit the number of blasting related activities and noise levels, and take into consideration aquatic features.

Light

11.8.29 The levels of lighting required during construction are currently unknown, however, it is predicted that lighting will be required where construction will take place during hours of darkness, particularly in winter periods. Brown trout are the primary IEF inhabiting the pelagic and littoral zones and therefore most sensitive to light pollution, notably where existing populations are not habituated to artificial light sources. Floodlit watercourses and/or waterbodies increase the likelihood of displacement and / or predation of fish. Any areas effected by excess lighting will compromise a small area in the context of Loch Earba. The significance of this effect prior to mitigation is considered to be **Minor (Not Significant)** for brown trout. Arctic charr do not occupy pelagic habitats in Loch Earba and light is unlikely to reach benthic habitats, and at a level sufficient to cause harm, therefore likely significant impacts are considered to be **Minor (Not Significant).**

11.8.30 Zooplankton are known sensitive receptors to artificial light pollution. This has the potential to disrupt natural rhythms on a daily, lunar (monthly) and seasonal scale which may influence feeding, breeding and/or natural movement patterns. This has the potential to reduce and fragment populations. The significance of this effect prior to mitigation is considered to be **Minor (Not Significant)**.

11.8.31 Macroinvertebrates are known sensitive receptors to artificial light pollution, similar to their prey species (e.g. zooplankton). This has the potential to disrupt natural rhythms on a daily, lunar (monthly) and seasonal scale as they mimic change in patterns in line with prey species distribution. The significance of this effect prior to mitigation is considered to be **Minor (Not Significant)**. This additionally has the potential to impact prey availability for fish and avian/mammal predators (e.g. divers and otters). For affect on reduction of fish as a prey species refer to **Chapter 8: Terrestrial Ecology**.

Invasive non-native species

11.8.32 Inadvertent introduction of invasive non-native species (INNS) may occur through increased traffic during the construction phase. Introduction of INNS will be mitigated within the CEMP.

[29] Nedwell, J., Turnpenny, A., Lovell, J. and Edwards, B. (2006). An Investigation into the Effects of Underwater Piling Noise on Salmonids. *Journal of the Acoustical Society of America.* 120(5). pp. 2550-2554.

[30] Kolden, K. D. and Aimone-Martin, C. (2013). Blasting Effects on Salmonids. Alaska Department of Fish & Game.

Table 11.13 Summary of likely Construction Phase Impacts and effects on IEFs Prior to Mitigation

IEF/ Importance Level	Impacts	Effect	Impact Scale	Significance of Effect Prior to Mitigation
Arctic charr / National	Construction works	Obstruction of migration between Loch Earba and spawning tributaries	Short term, medium, adverse effect	**Major**, significant
	Water quality	Dust and pollution run off	Short term, low, adverse effect	**Moderate**, significant
	De-watering Loch Leamhain	Lowering of water level, concentrating populations and increased inter-species interactions.	Short term, medium, adverse effect	**Major**, significant
	Quarrying	Changes in water quality and fish habitat.	Short term, low, adverse effect	**Moderate**, significant
	Noise	Behavioural responses of avoidance. Acute physical injury or mortality.	Short term, negligible, adverse effect	**Minor**, Not Significant
	Vibration	Behavioural responses of avoidance. Acute physical injury or mortality.	Short term, negligible, adverse effect	**Minor**, Not Significant
	Construction lighting	Displacement and increased predation risk	Short term, Negligible, adverse effect	**Minor**, Not Significant
Brown trout / Local	Construction works	Displacement, mortality and/or displacement.	Short term, medium, adverse effect	**Minor**, Not Significant
	Water quality	Dust and pollution run off	Short term, medium, adverse effect	**Minor**, Not Significant
	De-watering Loch Leamhain	Lowering of water level, concentrating populations and increased inter-	Short term, medium, adverse effect	**Minor**, Not Significant

IEF/ Importance Level	Impacts	Effect	Impact Scale	Significance of Effect Prior to Mitigation
		species interactions.		
	Quarrying	Changes in water quality and fish habitat.	Short term, low, adverse effect	**Minor**, Not Significant
	Noise	Behavioural responses of avoidance. Acute physical injury or mortality.	Short term, medium, adverse effect	**Minor**, Not Significant
	Vibration	Behavioural responses of avoidance. Acute physical injury or mortality.	Short term, medium, adverse effect	**Minor**, Not Significant
	Construction lighting	Displacement and increased predation risk	Short term, Negligible, adverse impact	**Minor**, Not Significant
Macroinvertebrates / Local	Quarrying	Changes in water quality and fish habitat.	Short term, low, adverse effect	**Minor**, Not Significant
	Construction lighting	Disruption to natural rhythms and prey species movement patterns, impacting feeding, breeding and/or natural movement patterns,	Short term, low, adverse effect	**Minor**, Not Significant
	Water quality	Dust and pollution run off (P. conventus)	Short term, medium, adverse effect	**Moderate**, significant
Macrophytes / Local	Quarrying	Changes in water quality and fish habitat.	Short term, low, adverse effect	**Minor**, Not Significant

Operational Effects

11.8.33 The operation phase is predicted to last indefinitely, consequently all duration of effects are predicted to be permanent (30+ years).

Loss of spawning habitat due to permanent and/or temporary inundation

11.8.34 Riverine salmonid spawning habitat (applicable to Arctic charr and brown trout) has the potential to be impacted by the inundation at Loch Earba due to the increased depth of maximum inundation and frequent fluctuations in water level. Water levels affected include the Moy Burn, Allt Coire Pitridh and the connective river between the Loch Earba basins. Suitable habitat was within a very localised area (connecting river between Loch Earba basins, Moy Burn and Allt Coire Pitridh). All suitable riverine spawning substrate identified is predicted to be inundated. The significance of this effect for Arctic charr prior to mitigation is **Major (Significant)** and **Minor (Not Significant)** for brown trout.

11.8.35 Salmonid spawning (applicable to Arctic charr and brown trout) in loch margins has the potential to be impacted by the increase of average water levels, above current levels and equal to minimum drawdown loch level. The proposed reservoir operating levels will permanently submerge current spawning areas outwith established viable thresholds impacting egg viability and hatch rate. The significance of this effect for Arctic charr prior to mitigation is **Major (Significant)** and **Minor (Not Significant)** for brown trout.

Fish attraction to the intake

11.8.36 The fish present do not typically display migratory pathways within waterbodies, therefore under the precautionary principle it is assumed that fish will likely be present around the proposed location of the intake structures. Brown trout are known to demonstrate a rheotactic movement response to currents/flowing water[31], however, this may not be as strong a response as other migratory salmonids (e.g. Atlantic salmon or sea trout). Attraction towards the screen during abstraction periods would increase energy expenditure and make fish more vulnerable to predation from mammalian (e.g. otter) and avian predators (e.g. divers).

11.8.37 Ingress and entrainment of fishes within the 'pipe structures' presents risk of injury, mortality and/or transfer of individuals between Loch Earba and Loch Leamhain. Given high morphological and phenotypic variations in Arctic charr recorded within other lochs in Scotland[32], and the isolation of individuals within Loch Leamhain, it is considered under the precautionary principle that individuals in Loch Leamhain are also genetically distinct. The best practice guide for screening for intakes and outfalls recommend screens dimensions of ≤12.5 mm to protect migratory salmonids from hydro scheme infrastructure[33], a maximum mesh size of 12.5 mm will be employed at the intake. The significance of this effect for Arctic charr prior to mitigation is **Minor (Not Significant)** and **Not Significant** for brown trout. Eurasian minnow are present only in Loch Earba, and not Loch Leamhain, therefore transfer of live individuals has the potential to introduce an invasive non-native species (INNS). The species is associated with competition for brown trout for food and space, and are additionally known to prey on salmonid eggs and fry in marginal areas. Introduction of a single minnow is unlikely to have a significant effect, however, the introduction of multiples individuals and the establishment of a

[31] O'Keeffe, N. & Turnpenny, A.W.H. (2005) Screening for Inlet and Outlets: a best practice guide. Science Report SC030231. Environment Agency: Bristol

[32] Maitland, P. S. and Adams, C. E. (2017). Arctic Charr in the Lochs of Scotland: An Assessment of Distribution and Status.

[33] Turnpenny, A.W.H. and O'Keeffe, N. (2005). Screening for Intake and Outfalls: a best practice guide. [Online] Available at: Microsoft Word - W6_103 TR _amended__1.doc (publishing.servici.e aov.uk)

breeding population is considered likely to have a negative effect on salmonid populations, notably brown trout. The significant of this effect Arctic charr prior to mitigation is **Minor (Not Significant)** and **Not Significant** for brown trout.

11.8.38 Fish present near the intake screens pose a risk of impingement against intake screens. The sustained swimming speed of salmonids for 0.15 m body length is 0.54 m/s[34] and the predicted maximum velocity approaching the intake is less than 0.3 m/s, therefore juvenile salmonids would have the ability to overcome the draw of the intake velocity voluntarily preventing any injury / mortality associated with impingement on the screens. Regular clearing of the intake screen should prevent debris build-up that may increase approach velocities across the screen outwith escapable velocities. The significance of this effect for Arctic charr prior to mitigation is **Minor (Not Significant)** and **Not Significant** for brown trout.

Fluctuations in Water Levels

11.8.39 Fishes may be impacted by the fluctuations in water level within Loch Earba and Loch Leamhain. Loch Earba is expected to fluctuate approximately 22 m and Loch Leamhain approximately 70 m.

11.8.40 Fish occupying newly flooded areas at maximum inundation may become stranded on dry land or within small puddles when the water level recedes during generation/pumping periods. This would place individuals at greater risk of injury, mortality and/or predation. It is anticipated that most fish will track receding water levels during generation/pumping periods. Arctic charr are not anticipated to be impacted given their tendency to occupy deeper loch areas at 20 m+ depth (and not littoral zones primarily affected). The significance of this effect for brown trout prior to mitigation is considered to be **Minor (Not Significant)**.

11.8.41 Spawning areas on loch margins of both Loch Earba and Loch Leamhain have the potential to be impacted by water level fluctuations as a result of generation cycles. Due to relative homogeneity of substrate in marginal/littoral areas there is a risk that fishes may spawn in suitable areas (shallow gravel/pebble) in shallow waters during periods of artificially elevated water levels. Eggs deposited in such habitats may become aerially exposed as a result of subsequent water level reduction, with a consequent reduction in viability and hatch success. The significance of this effect for Arctic charr prior to mitigation is considered to be **Major (Significant)** and **Minor (Not Significant)** for brown trout.

11.8.42 Although many Arctic charr populations spawn in the littoral zone, some spawn at greater depths. Studies in Lake Windermere suggested a spawning depth of 1-3 m were used by Autumn spawners (peak in November) whilst deeper spawning grounds ranged from 15-20 m in depth[35].

11.8.43 Plankton species are unlikely to be affected with fluctuating water levels compared to littoral zone species likely to be affected by water level change. This is unlikely to impact plankton feeding Arctic charr morphs, however, zoobenthos, favoured

[34] Tang, J. & Wardle, C. S. (1992) Power Output of Two Sizes of Atlantic Salmon (*Salmo Salar*) at their Maximum Sustained Swimming Speeds. The Journal of Experimental Biology Volume 166. pp. 33-46

[35] Frost, W.E. (1965). Breeding habits of Windermere charr, *Salvelinus willughbii (Günther)* and their bearing on speciation of these fish. Proceedings of the Royal Society, Series B 163: 473 232-284.

by brown trout are likely to be significantly affected[36,37]. The significance of this effect is considered to be **Minor (Not Significant)** for Arctic charr and brown trout.

11.8.44 Food sources for Arctic charr, pelagic and benthic sources will be less affected by fluctuations of water levels than other fish species (e.g. brown trout) which feed within the littoral zone, and are therefore more likely to be affected by fluctuations in water levels. The significance of this effect is considered to be **Minor (Not Significant)** for Arctic charr and brown trout.

Dams

11.8.45 The dam footprints will result in permanent fragmentation of habitat within the tributary and loch habitat on Allt Coire Pitridh, Allt Coire a' Chlachair and the Allt Loch a' Bhealaich Leamhain. This would prevent direct access to spawning areas for loch dwelling Arctic charr and brown trout. Access between the Allt Coire Pitridh and Allt Coire a' Chlachair, and Loch Earba will be maintained via diversion channels, however, migratory distance/periods for fish travelling to the Allt Coire a' Chlachair will be in excess of those for the current route. The significance of this effect is considered to be **Moderate (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout due to the low magnitude of potential impact.

11.8.46 Access between Loch Leamhain and the Allt Loch a' Bhealaich Leamhain will be permanently fragmented for Arctic charr and brown trout. The dam footprint is predicted to cover some existing suitable spawning substrate. This will permanently prevent loch dwelling Arctic charr and brown trout from reaching riverine spawning areas. The significance of this effect is considered to be **Major (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout.

11.8.47 Current access to the Allt Labrach is limited by existing hydropower infrastructure, therefore no significant effects are predicted from the Proposed Development. Compensation flow to the Allt Labrach proposed as a mitigation for the Proposed Development is considered to have a positive effect.

11.8.48 Catastrophic failure of the Loch Leamhain dam would be likely to result in a significant surge of water (volume dependent on generation cycle) from Loch Leamhain, affecting the Allt Loch a' Bhealaich Leamhain, Allt Cam and Loch Pattack. Such water movement is likely to wash away sediments, fishes, macroinvertebrates and macrophytes in the Allt Loch a' Bhealaich and Allt Cam, resulting in (expected) total loss of species present. Additionally, Loch Pattack downstream is likely to be affected by a significant water surge that may displace fishes resulting in injury and/or mortality with an extreme deterioration in water quality. The significance of this effect before mitigation is considered to be **Major (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout, macroinvertebrates and macrophytes.

11.8.49 Catastrophic failure of the Loch Earba dams Shios and Shuas would be likely to result in a significant surge of water (volume dependent on generation cycle) from Loch Earba, affecting the adjacent water courses Allt Labhrach (Shios) and the Allt Coire Pitridh and Allt Coire a' Chlachair (Shuas). The significance of this effect

[36] Maitland, P. S. and Adams, C. E. (2017). Arctic Charr in the Lochs of Scotland: An Assessment of Distribution and Status.

[37] Maitland, P. S. (1992). The status of Arctic Charr *Salvelinus alpinus,* (L.). In Southern Scotland: A Cause For Concern. Freshwater Forum 2: pp. 8.

before mitigation is considered to be **Major (Significant)** for Arctic charr and **Minor (Not Significant)** for brown trout, macroinvertebrates and macrophytes.

Noise and Vibration

11.8.50 All fish species have the potential to be impacted by operational noise and vibration associated with the Proposed Development. Anticipated effects are expected to be non-lethal for fish but may cause temporary displacement and avoidance of the area around the inlet/outlet pipe. Blasting within watercourses/marginal areas is not predicted. Positive effects may be experienced in that displacement resulting from noise and vibration avoidance would mitigate effects associated with abstraction and generation (e.g. impingement). The significance of this effect for all species is considered to be **Not Significant / Minor (Not Significant)**.

11.8.51 Limited staff presence and maintenance during the operational period, and associated road traffic noise, is likely to have a negligible impact on IEFs and has been scoped out of the assessment.

Light

11.8.52 All fish species have potential to be affected by artificial lighting during crepuscular/nocturnal periods. The powerhouse building will not have permanent lighting or Passive Infrared Sensors (PIR), and light will not escape from the building during operation. The use of light outside will be restricted to specific external tasks and require manual operation of light. Anticipated effects are expected to be local displacement and avoidance of the area around the Proposed Development during periods of use, however, this is minimal both in duration of use and area of loch affected. The significance of this effect for all species prior to mitigation is considered to be **Minor (Not Significant) / Not Significant** due to low magnitude of impact and temporary duration.

11.8.53 Macroinvertebrates are known sensitive receptors to artificial light pollution. Light has the potential to disrupt natural rhythms on a daily, lunar (monthly) and seasonal scale which may influence feeding, breeding and/or natural movement patterns with the potential to reduce and fragment populations. Due to the lack of light pollution and expected infrequent short-duration use the significance of this effect prior to mitigation is considered to be **Minor (Not Significant)**

Temperature Changes Through Water Transfer

11.8.54 Fish species have the potential to be impacted by temperature changes through water transfer between Loch Earba and Loch Leamhain.

11.8.55 Minimal variation was observed in surface water temperatures between Loch Leamhain and Loch Earba during baseline surveys (variation of averages was 0.95°C March-September; Loch Leamhain variation 7.1 -11.3°C; Loch Earba 9.6 – 11.5°C). Where receptive bodies vary in temperature, small variations are unlikely to be sufficient to cause thermal shock to individuals, with temperatures likely to return quickly to ambient levels. Regular generation cycles will prevent large differences in water temperature from developing. Optimal Arctic charr temperature

ranges between 4.5°C to 11.6°C38,39 and are tolerant of lower temperature ranges. Sudden temperature variation of up to 2°C can modify physiology and behaviour40. Due to the localised nature, limited extent and duration of water temperature changes, the significance of this effect for Arctic Charr is Minor (Not Significant) and for brown trout is considered to be Not Significant.

11.8.56 Compensation flow released from the Shios dam into the Allt Labhrach will be low in temperature due to the discharge pipe located at the bottom of the dam where temperature is lowest. As there is currently no water in the Allt Labhrach immediately below the existing dam, water will not cause thermal shock to fish as they are not present, and fish will have the choice to actively move into this area of colder water after a flow is introduced. Water downstream may decrease in temperature, however, in light of projected water temperature increases this may be beneficial in buffering this effect. Due to the localised nature and potential positive effect the significance of this effect for brown trout is considered to be **Not Significant**.

Water Quality

11.8.57 Increased water level fluctuation and reduction in macrophyte growth will lead to destabilisation of the drawdown zone and a consequent erosion of marginal substrate. This may lead to increases in water quality parameters within thresholds capable of causing injury and/or mortality (e.g. total dissolved solids and/or turbidity). Due to the impact occurring over months/seasons water quality deterioration is likely to be gradual and not in concentrations consistent with major pollution events. The significance of this effect for macrophytes is considered **Minor (Not Significant)**. Macrophyte reduction is likely to affect macroinvertebrate that reside in areas of macrophyte growth, with consequent affects on littoral zone feeders, e.g. brown trout. The significance of this effect for macroinvertebrates and brown trout is **Minor (Not Significant)**.

11.8.58 Generating/pumping periods may increase silt mobilization within the water column resulting in increased turbidity localised at the inlet/outlet pump. Due to predicted deterrence of fishes from the area due to operational noise and vibration it is unlikely fishes will be present within the affected area. Due to the localised nature, limited extent and duration of likely turbidity increases, the significance of this effect for Arctic Charr is **Minor (Not Significant)** and for brown trout is considered to be **Not Significant**.

[38] Larsson, S., Forseth, T., Berglund, I., Jensen, A.J., Näslund, I., Elliott, J.M. And Jonsson, B. (2005), Thermal adaptation of Arctic charr: experimental studies of growth in eleven charr populations from Sweden, Norway and Britain. Freshwater Biology, 50: 353-368. https://doi.org/10.1111/j.1365-2427.2004.01326.x

[39] Siikavuopio, S. I., Sæther, BS., Johnsen, H. et al. (2014) Temperature preference of juvenile Arctic charr originating from different thermal environments. Aquatic Ecology. 48, 313–320. https://doi.org/10.1007/s10452-014-9485-0

[40] Leblanc, C. A., Horri, K., Skúlason, S., Benhaim, D. (2019) Subtle temperature increase can interact with individual size and social context in shaping phenotypic traits of a coldwater fish PLoS ONE 14(3): e0213061. https://doi.org/10.1371/journal.pone.0213061

Table 11.14 Summary of Operational Phase Impacts and Effects on IEFs Prior to Mitigation

IEF / Importance Level	Impacts	Effect	Impact Scale	Significance of Effect Prior to Mitigation
Arctic charr / National	Loss of spawning habitat (permanent / temporary inundation)	Permanent loss of salmonid spawning habitat in loch margins	Permanent, High, Adverse effect	**Major**, Significant
	Fish attraction to intake	Entrainment, injury, mortality and/or translocation of fish	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
	Fluctuations in Water levels	Stranding in drawdown zone, injury, mortality and/or predation	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
	Habitat Fragmentation	Habitat fragmentation, complete loss and/or loss of connectivity to spawning habitat	Permanent, High, Adverse effect	**Major**, Significant
	Noise and Vibration	Local displacement, injury, mortality	Permanent, Negligible, Adverse effect	**Minor,** Not Significant
	Light	Local displacement	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
	Temperature variation	Thermal shock	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
	Water Quality	Increased turbidity resulting in habitat quality deterioration	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
Brown trout / Local	Loss of spawning habitat (permanent / temporary inundation)	Permanent loss of salmonid spawning habitat in loch margins	Permanent, High, Adverse effect	**Minor**, Not Significant

IEF / Importance Level	Impacts	Effect	Impact Scale	Significance of Effect Prior to Mitigation
	Fish attraction to intake	Entrainment, injury, mortality and/or translocation of fish	Permanent, Low, Adverse effect	**Minor**, Not Significant
	Fluctuations in Water levels	Aerial stranding in drawdown zone, injury, mortality and/or predation	Permanent, Medium, Adverse effect	**Minor,** Not Significant
	Habitat Fragmentation	Habitat fragmentation, complete loss and/or loss of connectivity to spawning habitat	Permanent, High, Adverse effect	**Minor**, Not Significant
	Noise and Vibration	Local displacement, injury, mortality	Permanent, Low, Adverse effect	Not Significant
	Light	Local displacement	Permanent, Negligible, Adverse effect	Not Significant
	Temperature variation	Thermal shock	Permanent, Negligible, Adverse effect	Not Significant
	Water Quality	Increased turbidity resulting in habitat quality deterioration	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
Macroinvertebrates / National (Psidium conventus), Local (all other species	Fluctuations in Water levels	Aerial stranding in drawdown zone, injury, mortality and/or predation	Permanent, Medium, Adverse effect	**Minor**, Not Significant
	Water Quality	Increased turbidity resulting in habitat quality deterioration	Permanent, Negligible, Adverse effect	**Minor**, Not Significant
Macrophytes / Local	Fluctuations in Water levels	Aerial stranding in drawdown zone resulting in reduced density	Permanent, Medium, Adverse effect	**Minor**, Not Significant
	Water Quality	Increased turbidity resulting in habitat quality deterioration	Permanent, Negligible, Adverse effect	**Minor**, Not Significant

Cumulative Effects

11.8.59 This section details the cumulative effects of other potential developments, e.g. those which are operational, consented, submitted for planning approval, in combination with the Proposed Development. These effects are those which are additional to those of the Proposed Development in its own right. There must be a clear route to potential cumulative effects due to the following :

1. Developments within or adjacent to the same catchments as this Proposed Developments; and

2. Developments affecting the same habitats and migratory species within 5km of the Proposed Development;

11.8.60 An existing development was identified within Loch Earba, the 1 MW Ardverikie hydro scheme. This is not predicted to be impacted by the Proposed Development, however, adverse effects caused by the existing development (no compensation flow to the Allt Labhrach) will be mitigated through the Proposed Development. The significance of this effect is likely a high magnitude positive effect.

11.8.61 An existing development was identified downstream of the Proposed Development, the Lochaber Hydropower Scheme. This is not predicted to be impacted by the Proposed Development, except during the reservoir filling stage of the Proposed Development, during which a small percentage of flows from its catchment would be retained. Fish populations are unlikely to be affected by the construction and/or operation of the Proposed Development.

11.8.62 A further existing hydro scheme is on the River Pattack, downstream of the proposed Leamhain reservoir. As the natural flows from Loch Leamhain would be maintained throughout construction and operation of the Proposed Development, there are no predicted impacts by or on this scheme.

Construction effects

11.8.63 No cumulative effects during the construction phase have been identified at this stage.

Operational Effects

11.8.64 Existing hydro schemes on Loch Earba in addition to changing climatic conditions are likely to have contributed to a depletion of Arctic charr populations prior to the Proposed Development, resulting in an unfavourable condition status. Further adverse effects on Arctic charr have the potential to further decrease population.

11.8.65 Existing hydro schemes on Loch Earba are likely to have contributed to a depletion of macrophyte and macroinvertebrate population and species diversity around loch margins. Two operational dams between the Loch Earba basins have the capacity to manipulate water levels by several meters. This artificial water level regimes has contributed to a depleted drawdown zone.

11.9 Mitigation

Mitigation During Construction

11.9.1 This section considers good practice measures and generic mitigation that will be employed during the construction and operational phases.

11.9.2 A Construction Environmental Management Plan (CEMP), Pollution Prevention Plan (PPP), Dust Mitigation Plan and Surface Water Quality Monitoring Programme (SWQMP) will be implemented by the Principal Contractor and overseen by an ACoW (Aquatic Clerk of Works) or suitably experienced ECoW. A water quality sampling suite should be designed to cover likely present pollutants and undertaken at timescale to allow sufficient actions to be taken in the case of pollution incidents. Correct implementation of PPP and the SWQMP should result in negligible observable effect to IEFs.

11.9.3 Aquatic elements will be incorporated into the Construction Noise and Vibration Management Plan (CNVMP) to ensure noise and vibration limits are not in excess of limits capable of causing injury and/or mortality to fishes. This will reference any blasting likely to occur within marginal areas of watercourses and waterbodies.

11.9.4 Instream works will be avoided, where practical, during sensitive spawning and localised migration periods for fish. Sensitive periods are October – June to cover salmonid spawning, egg development in gravels and hatching. Due to the programme of works, there are instances where instream works cannot be avoided during sensitive spawning and migration periods for fish and appropriate additional mitigation will be provided where this is the case.

11.9.5 For the installation of any culverts on the access track, fish rescue and relocations should be taken prior to the damming / dewatering of the watercourse. This will protect any fish populations in the vicinity of the works from harm.

11.9.6 During the construction of the Shuas dam, juvenile Arctic charr present in the Allt Coire Pitridh will become isolated from Loch Earba, and will be unable to migrate to the loch when they reach a certain size. An increase in adult fish in the Allt Coire Pitridh will increase pressures on food availability and provide unsuitable habitat. Fish of a suitable size will be identified and removed, via electrofishing, and placed in the lower reaches of the Moy Burn to allow them to migrate into Loch Earba.

11.9.7 During the construction of the Shuas dam an appropriately designed culvert will be maintained, where possible, to allow the passage of fish from Loch Earba into the Allt Coire Pitridh (to spawn), and to allow juvenile fish to move into Loch Earba.

11.9.8 In line with MarineScotland guidance for the monitoring of watercourses in relation to onshore wind farm developments: generic monitoring programme[41], the following monitoring measures are to be employed. Guidance specific to large pumped storage hydro schemes does not exist and it is considered that pollution

[41] MarineScotland. (2021). Monitoring watercourses in relation to onshore wind farm developments: generic monitoring programme. [Online] Available at: https://www.gov.scot/publications/monitoring-watercourses-in-relation-to-onshore-wind-farm-developments-generic-monitoring-programme/

pathways will be similar, thus the guidance is applicable to the Proposed Development.

- To develop a reasonable baseline dataset from which to detect change it is important that sampling takes place during construction and for a period of at least a year after construction. Sampling should take place at intervals no greater than one month unless sensitive periods / constraints have been identified, e.g. concrete batching or known acidification problems. More frequent sampling of selected parameters, e.g. pH and turbidity should occur more frequently and can be undertaken *in-situ* by the ECoW.
- *Ex-situ* water analysis should be undertaken by an appropriately qualified laboratory (e.g. United Kingdom Accredited Service (UKAS)). Water quality parameters included are: turbidity (NTU) in relation to site disturbance; dissolved organic carbon (DOC) (mgl^{-1} ppm) in relation to site disturbance and peat deposits; pH, alkalinity ($\mu eq\ l^{-1}$), acid neutralising capacity ($\mu eq\ l^{-1}$) and aluminium (μgl^{-1}) in relation to changes in hydrology, DOC export and acidification; total oxidised nitrogen (nitrate and nitrite) (mgl^{-1}) and phosphate in relation to nutrient leaching (μl^{-1}); stream height; temperature; and dissolved oxygen concentration (mgl^{-1}) and biological oxygen demand to indicate health of water. Sampling should occur pre-construction to provide a robust data set and monthly during construction.
- Regular visual inspections of all watercourses (flow conditions, discolouration, collection of debris, fish in distress/floating) should be presented in a monthly water quality report and advised by an independent suitably qualified ECoW.
- Macroinvertebrate sampling should occur during construction on relevant watercourses, and at least one control site, at a minimum of once a year, preferably in Spring.
- Electrofishing should be undertaken once a year during construction and at least once a year after. Surveys should be fully-quantitative and include at least one control site. Surveys should be conducted late in the survey season to allow brown trout and Arctic charr fry to be distinguished.

11.9.9 Construction lighting should emit light from a broad spectrum of light with high UV components avoided; most invertebrates are sensitive to short wavelengths of light where greatest behavioural change occur. Lighting should additionally face away from watercourse/waterbodies where it is practical to do so.

11.9.10 Any lighting used during construction should be directed away from the loch edges and watercourses to prevent the risk of increased predation of fish during the hours of darkness.

11.9.11 Any piling operations should adopt a ‘soft start’ approach to allow adult fish within the immediate vicinity of the cofferdam works area to disperse unharmed. The ACoW should monitor loch areas in the vicinity of the works for any fish kills in relation to works producing underwater noise.

11.9.12 De-watering operations of Loch Leamhain during construction phase should have suitable designed drainage and silt mitigation measures to prevent a deterioration of water quality during the construction phase via surface run-off.

11.9.13 It is proposed that a portion of the Arctic charr population be removed, in the form of fertilised eggs, and be translocated to an identified suitable receptor site to act as a refuge population. This is to act as a safeguard to the existing population within Loch Leamhain in the case of depletion or extinction of Arctic charr

presence, and to preserve a likely genetically distinct population. The refuge population would be able to supplement or reintroduce Arctic charr during the operational phase. A suitable receptor site will have no existing Arctic charr, or a morph suitably different from those in Loch Leamhain to prevent cross-breeding of different morphs and genetic divergence from the original population, and to allow individuals to be re-identified and captured at a later date. A translocation would be subject to approval by NatureScot.

Mitigation During Operation

11.9.14 Riparian planting would occur along watercourses not effected by inundation levels (in tandem with peat restoration works). This would aid in improving instream habitat quality by providing instream and bankside cover for fish and would aid in preventing water temperature increases, notably in light of future predicted baselines.

11.9.15 Compensation flow would be permanently introduced to the Allt Labhrach, commencing once the Earba reservoir has been filled. The stretch of the Allt Labhrach below the current dam is dry and was considered to be Not Suitable to house any fish species, this would provide additional habitat for fish present.

11.9.16 Compensation flow would be maintained to the Allt Loch a' Bhealaich Leamhain at all times. Natural flow regimes would be mimicked by matching compensation flow to typical flow; this would vary monthly. This is considered more natural than typical freshet events used to mimic natural flow regimes.

11.9.17 Spawning habitat creation on the Moy burn higher than inundation levels would provide spawning habitat in excess of what is lost. Due to a risk of introduced spawning gravels being washed out of the watercourses by spate events a short diversion channel could be created running parallel to the existing Moy burn. This would direct a controlled flow of water over optimal spawning gravels. The rate of flow and water depth is set/controlled to provide stable, optimal conditions unlikely to be impacted by spate events. This will also improve accessibility to the upper reaches of the Moy Burn by bypassing barriers (where present). Riparian planting on spawning channel margins would provide stability to marginal areas and provide spawning habitat quality improvements through shading and/or water temperature regulation. Designs would be subject to approval by NatureScot and SEPA.

11.9.18 The connection of the Allt Choire Pitridh and the Allt a' Choire Chlachair to Loch Earba via a new aqueduct channel will maintain accessibility of the watercourses to spawning tributaries. Arctic charr and brown trout will be able to access the aqueduct channel during all reservoir levels. Additionally, upper sections of the aqueduct (upper straight sections) will be designed in a manner to contain optimal spawning substrate. Due to the nature of the aqueduct holding smaller volumes of water than the Moy burn the risk of substrates washing out during spate events is minimal. This will improve on spawning habitat lost to the dam construction and inundation levels; there are no likely predicted impacts on water quality.

11.9.19 Marginal loch spawning habitat would be maintained through the creation of habitat in the form of terraced 'pools' approximately 1 m deep. This would be designed to contain optimal spawning substrate types for both Arctic charr and brown trout; current spawning opportunities on loch margins is low due to existing depleted drawdown zones, thus presenting an opportunity for enhancement. Additionally, the empty borrow pits (used for aggregate extraction) would provide additional marginal spawning habitat opportunities when terraced.

11.9.20 Terraced pools on loch margins would provide maintained macrophyte and macroinvertebrate habitat opportunities. Macrophyte species identified within baseline surveys would be planted within terraced areas in greater densities to provide equal and/or improved habitat for fish and macroinvertebrates. This would additionally aid in sustaining a food source for littoral zone feeders (e.g. brown trout). Whilst there is an acknowledged risk of fish entrapment in pools, this is considered of lower impact than not providing compensatory macrophyte and macroinvertebrate populations.

11.9.21 Artificial floating spawning nests would be installed into Loch Leamhain and Loch Earba. It is proposed that the artificial structures incorporate known spawning requirements of Arctic charr including depth, depth of substrate and type of substrate. Structures would be suspended via buoys at a constant depth to maintain favourable depth. This would be anchored to the loch bed with sufficient chain to allow the structure to rise and recede with the fluctuations in water level during operational periods. Construction of nests would additionally protect fish eggs from destruction, for example, aerial exposure due to water level decrease and/or predation. The specific measures proposed would be novel in design, however, suspended spawning substrate, e.g. Kiddle spawning grounds[42] are recognised as an established mitigation measure. This will additionally provide suitable conditions for macrophytes and macroinvertebrates to establish. It is proposed monitoring would be undertaken (*in-situ* or *ex-situ*) to monitor success. Nests would be deployed during the three year construction phase to compensate for lost access to potential historical spawning grounds in the form of alternative spawning areas. This additionally encourages use prior to the operational period. This mitigation measure will be subject to design approved by NatureScot.

11.9.22 Water quality monitoring post-construction and during the first years of operation would be conducted in line with MarineScotland guidance[41] as stipulated in Section 11.9.6. *In situ* sondes and dataloggers with data telemetry units can be installed to provide long term real time data if required.

11.9.23 Catastrophic failure of the Loch Leamhain dam would be likely to result in a significant surge of water (volume dependent on generation cycle) effecting the downstream watercourses Allt Loch a' Bhealaich Leamhain, the Allt Cam and Loch Pattack. Catastrophic failure is considered extremely unlikely due to the high standard of design, management, and maintenance required under the Reservoirs (Scotland) Act 2011. As required by the Act, routine inspection of the dams would be undertaken. Therefore the significance of this effect is considered to be **Not Significant** for all species.

11.10 Residual Effects

11.10.1 This section considers the potential residual effects and associated effect significance of the construction and operation of the Proposed Development, following the implementation of the mitigation measures proposed in **Section 11.9**.

Construction Residual Effects

11.10.2 Residual impacts to water quality are likely to remain as a result of prolonged construction works. Effects will be mitigated through the implementation of a

[42] Marenkov, O. and Fedonenko, O. (2016) Ways of optimization of breeding conditions of fish by using artificial spawning grounds. *World Scientific News.*

CEMP, PPP, SWQMP and CNVMP. Impacts are notable for fish within the de-watered Loch Leamhain where effects of incidental pollution incidents will occur within a higher population density of receptor fish and reduced water volume, with reduced buffering capacity.

11.10.3 Residual impacts of de-watering of Loch Leamhain are likely to remain to fish species as a result of reduced food availability (due to depleted macrophyte and macroinvertebrate densities resulting from habitat loss) and volume of water resulting in increased competition for resources. Due to a reduction of water depth there is likely greater interaction between pelagic and benthic species, competing for limited resources, this would negatively effect both populations.

11.10.4 Residual noise and vibration effects are likely to affect individuals, notably brown trout, feeding in littoral zones and closest to construction works. The implementation of a suitable CNVMP would mitigate against noise levels specific to the IEFs identified and employ best practice techniques such as soft start piling.

Operational Residual Effects

11.10.5 During the operation of the Loch Leamhain reservoir, access to the Allt Loch a' Bhealaich Leamhain would not be maintained and an operational fish pass would not be installed. Fish present in Loch Leamhain would not be able to access the Allt Loch a' Bhealaich Leamhain for spawning. Currently spawning is likely to occur in this watercourse due to the presence of both Arctic charr and brown trout fry.

11.10.6 During the operation of Loch Leamhain reservoir, access to marginal areas for spawning would be prevented, however, with the implemented mitigation measures of artificial spawning areas this is expected to be considerably reduced. Fish may take a number of years / spawning seasons to adapt to changes within their environment with a subsequent decrease in egg viability. Consequently, Arctic charr and trout populations would initially decrease, however, this is expected to be a short term affect. Due to this the significance of this effect for Arctic charr is considered **Moderate (Significant)** and **Minor (Not Significant)** for brown trout.

Cumulative Residual Effects

11.10.7 No cumulative residual effects were identified.

Table 11.15 Residual effects from Construction and Operation effects

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
Arctic charr	Noise and vibration during construction	**Minor,** Not Significant		Piling operations will adopt a 'soft start' approach to allow fish in the immediate vicinity of the works to disperse. The ACoW should monitor loch areas in the vicinity of the works for any fish kills in relation to works producing underwater noise.		**Minor,** Not Significant
	Dust and surface run off from construction work	**Moderate**, significant		A CEMP, PPP, CNVMP and SWQMP will be implemented by the Principal Contractor and overseen by an ACoW / ECoW. A suitably designed water quality monitoring regime will be implemented during construction and operational phases to detect any deterioration of water quality and implement suitable counter measures.		**Minor,** Not Significant

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
	Construction Lighting	**Minor,** Not Significant		Any floodlighting used during construction should be directed away from loch edges and watercourses to prevent the risk of increased predation of fish during the hours of darkness.		**Minor,** Not Significant
	Loss of spawning substrate (Loch Earba)	**Major,** Significant	Avoid instream works during sensitive spawning periods where practicable.		Diversion channel will be designed to incorporate optimal spawning areas, this will provide spawning areas in excess of existing conditions. Channel will additionally provide access to original spawning areas on the Allt Coire a' Chlachair and Allt Coire Pitridh. Areas on the Moy Burn above the inundation zone will be enhanced to minimise barriers where possible and to incorporate suitable spawning areas.	**Minor,** Not Significant

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
	Loss of access to spawning areas (Loch Leamhain)	**Major,** Significant		Installation of floating artificial spawning structures in Loch Leamhain to replace lost marginal spawning areas. Creation of a refuge population to supplement potential population decrease during de-watering of Loch Leamhain.		Moderate, Significant
Brown trout	Noise and vibration during construction	Not Significant		Piling operations will adopt a 'soft start' approach to allow fish in the immediate vicinity of the works to disperse. The ACoW should monitor loch areas in the vicinity of the works for any fish kills in relation to works producing underwater noise.		Not Significant
	Dust and surface run off from	Minor, Not Significant		A CEMP, PPP, CNVMP and SWQMP will be implemented by the Principal Contractor and		**Minor**, Not Significant

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
	construction work			overseen by an ACoW / ECoW.		
	A suitably designed water quality monitoring regime will be implemented during construction and operational phases to detect any deterioration of water quality and implement suitable counter measures.					Not Significant
	Construction Lighting	Not Significant		Any floodlighting used during construction should be directed away from loch edges and watercourses to prevent the risk of increased predation of fish		**Minor**, Not Significant

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
				during the hours of darkness.		
Macroinv-ertebrates	Construction Lighting	Minor, Not Significant		Any floodlighting used during construction should be directed away from loch edges and watercourses to prevent the risk of disruption to macroinvertebrate movement, behaviour and/or breeding.	Compensation flow will be provided to the Allt Labrach providing additional watercourse habitat.	Not Significant
	Dust and surface run off from construction work (*P. conventus*)	**Moderate**, Significant		A suitably designed water quality monitoring regime will be implemented during construction and operational phases to detect any deterioration of water quality and implement suitable counter measures.		Minor, Not Significant
Macro-phytes	Dust and surface run off from construction work	**Minor**, Not Significant		A suitably designed water quality monitoring regime will be implemented during construction and operational phases to detect any deterioration of water quality and		Not Significant

IEF	Impacts	Significance of Effect Prior to Mitigation	Avoidance	Mitigation	Compensation / Enhancement	Residual Significance of Effect
				implement suitable counter measures.		

11.11 Conclusion

11.11.1 The main conclusions from the impact assessment on aquatic ecology are described below:

Significant adverse effects have been identified on several of the important ecological features during both the construction and operational phases:

Construction Phase

- Impacts with a significant effect on Arctic charr were identified during the construction phase prior to mitigation including: construction works (**Major, Significant**); water quality changes (**Moderate, Significant**); de-watering Loch Leamhain (**Major, Significant**); quarrying (**Moderate, Significant**); noise (Minor, Not **Significant)**; vibration (**Minor, Not Significant**); construction lighting (**Minor, Not Significant**).
- Impacts on brown trout were identified during the construction phase prior to mitigation including: construction works, water quality changes, de-watering of Loch Leamhain, noise, vibration and construction lighting. The significance of all these effects prior to mitigation is considered **Minor (Not Significant)**.
- Impacts on macroinvertebrates were identified during the construction phase prior to mitigation including water quality changes and construction lighting. The significance of these effects prior to mitigation is considered **Moderate (Significant)** for *P. conventus.*
- Impacts on macrophytes were identified during the construction phase prior to mitigation include water quality changes. The significance of these effects prior to mitigation is considered **Minor (Not Significant)**.

Operational Phase

- Impacts with a significant effect on Arctic charr were identified during the operational phase prior to mitigation including: loss of spawning substrate (**Major, Significant**); fish attraction to intake (**Minor, Not Significant**); fluctuations in water levels (**Minor, Not Significant**); habitat fragmentation (**Major, Significant**); noise and vibration (**Minor, Not Significant**); light (**Minor, Not Significant**); temperature variation (**Minor, Not Significant**); and water quality (**Minor, Not Significant**).
- Impacts with a significant effect on brown trout were identified during the operational phase prior to mitigation including: loss of spawning substrate (**Minor, Not Significant**); fish attraction to intake (**Minor, Not Significant**); fluctuations in water levels (**Minor, Not Significant**); habitat fragmentation (**Minor, Not Significant**); noise and vibration (**Not Significant**); light (**Not Significant**); temperature (**Not Significant**); and water quality (**Minor, Not Significant**).
- Impacts on macroinvertebrates were identified during the operational phase including: fluctuations in water levels; and water quality. The significance of both effects prior to mitigation is considered **Minor (Not Significant)**.
- Impacts on macrophytes were identified during the operational phase including: fluctuations in water levels; and water quality. The significance of both effects prior to mitigation is considered **Minor (Not Significant)**.

Construction and Operational Residual

- Impacts with a significant effect on Arctic charr were identified during the construction and operational phase after mitigation including: noise and vibration during construction (**Minor, Not Significant**); dust and surface run off from construction work (**Minor, Not Significant**); construction lighting (**Minor, Not Significant**); loss of spawning substrate (**Minor, Not Significant**); and loss of access to watercourse spawning substrate (**Moderate, Significant**).
- Impacts on brown trout were identified during the construction and operational phase after mitigation including: noise and vibration during construction (**Not Significant**); dust and surface run off from construction work (**Minor, Not Significant**); construction lighting (Not Significant); loss of spawning substrate (**Minor, Not Significant**); and loss of access to watercourse spawning substrate (**Minor, Not Significant**).
- Impacts on macroinvertebrates were identified during the construction and operational phase prior to mitigation including: construction lighting (**Not Significant**); and dust and surface run-off from construction (**Not Significant**). The significance of these effects after mitigation is considered **Not Significant**.
- Impacts on macrophytes were identified during the construction and operational phase prior to mitigation include construction lighting. The significance of these effects after mitigation is considered **Not Significant**.

Cumulative Residual

- No cumulative residual effects were identified.

11.12 Abbreviation List

Table 11.16 Abbreviation List

Abbreviation	Explanation
ACoW	Aquatic Clerk of Works
BAP	Biodiversity Action Plan
CEMP	Construction Environmental Management Plan
CNVMP	Construction noise and vibration management plan
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EPS	European Protected Species
IEFs	Important Ecological Features
MSS	Marine Scotland Science
PPP	Pollution Prevention Plan
SAC	Special Area of Conservation
SBL	Scottish Biodiversity List
SPA	Special Protection Area
SSSI	Special Site of Scientific Interest
SWQMP	Surface Water Quality and Monitoring Plan
UKBAP	UK Biodiversity Action Plan

11.13 Terminology List

Table 11.17 Terminology List

Term	Explanation
Anadromous	The term that describes fish born in freshwater who spend most of their lives in saltwater and return to freshwater to spawn.
Entrainment	When fish become contained and trapped within infrastructure due to the water intake.
Ferox	Ferox trout is a traditional name for large, piscivorous trout, which in Scotland feed largely on Arctic charr.
Fry	After alevins have used up their yolk sacs these young salmonids are known as fry.
Impingement	Impingement is the physical contact of a fish with such a barrier structure (screen) due to intake velocities which are too high to allow the fish to escape.
Littoral Zone	Relating to or situated on the shore of a lake, where photosynthesis is possible.
Macroinvertebrate	An animal with no vertebral column which is visible to the naked eye.
Macrophyte	An aquatic plant which is visible to the naked eye.
Riparian	Relating to or situated on the banks of a river.
UK BAP (UK Biodiversity Action Plan)	A UK-wide plan outlining objectives for the improvement of biodiversity which identifies priority species and habitats as a focus for conservation and enhancement.