EARBA STORAGE

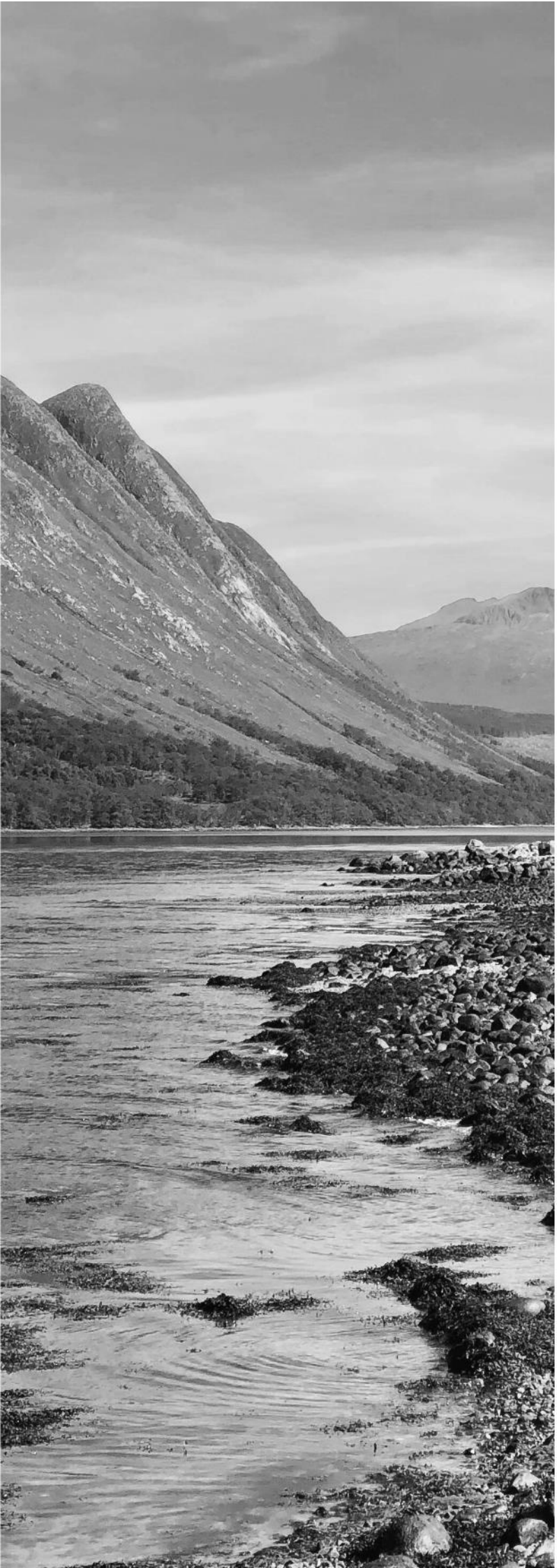
A GILKES ENERGY COMPANY

Earba Pumped Storage Hydro Scheme

CAR Licence Application Report

Appendix K: Arctic Charr Species Protection Plan

December 2024



ARCTIC CHARR SPECIES PROTECTION PLAN

EARBA PUMPED STORAGE HYDROSCHEME

EARBA LTD.

19/12/2024

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Revision History

Revision	Date	Prepared By	Reviewed By	Comments
V1.0	02/07/2024	[redacted]		Initial issue
V2.0	08/11/2024			Updated in response to client comments & project developments
V3.0	19/12/2024			Updated in response to client comments & project developments

Quality Assurance

This report has been prepared according to Gavia Environmental Quality Management Process. Gavia Environmental employs consultant scientists who are members of appropriate professional institutions and adhere to professional codes of conduct.

Disclaimer

This report is presented to Earba Ltd. in respect of an Arctic Charr Species Protection Plan, and may not be used or relied on by any other person or by the client in relation to other matters not covered specifically by the scope of this report.

Notwithstanding anything to the contrary contained in the report, Gavia Environmental Ltd is obliged to exercise reasonable skill, care, and diligence in the performance of the services required by Earba Ltd. and shall not be liable except to the extent that it has failed to exercise reasonable skill care and diligence, and this report shall be read and construed accordingly.

The report has been prepared by Gavia Environmental Ltd. No individual is personally liable in connection with the preparation of this report. By receiving this report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.

Contents

Executive Summary

Gavia Environmental Ltd. was commissioned by Earba Ltd. to compile a species protection plan for Arctic charr (*Salvelinus alpinus*), in relation to a proposed 1800 MW pumped storage hydroscheme and associated infrastructure on Loch Earba and Loch Leamhain located on the Ardverikie Estate, Scottish Highlands.

Arctic charr are considered vulnerable in Scotland, and are currently a UK Biodiversity Action Plan (UKBAP) fish species. To ensure protection of Arctic charr during the construction and operational phases of the Earba PSH scheme, a species protection plan (SPP) has been compiled.

A short desk study was undertaken to review previous protected species reports and recent species presence data through the NBN Atlas.

No designated sites with Arctic charr as a qualifying feature are present within 20 km of the Proposed Development or present upstream in the catchment. Additionally, the closest records of Arctic charr to the development was within Loch Laggan (approximately 2 km from Loch Earba).

Specialist external advice has been sought from [redacted] of University of Glasgow, a noted specialist in Arctic charr ecology in Scotland. A range of specific potential mitigation options have been considered, having consulted with [redacted] on their respective merits and risks.

A proposed series of mitigation options are proposed as part of the Earba PSH scheme, along with a justification for the decisions made.

It is proposed that a primary mitigation in the form of the artificial spawning areas located below the minimum loch level of the proposed combined Loch Earba is provided. A secondary mitigation, in the form of artificial floating spawning nests are proposed on a trial basis. There is currently no scientific literature documenting the success of this option for Arctic charr specifically (albeit their success for similar species is available), therefore it is proposed that this mitigation be provided as part of an independent academic study to assess their value to Arctic charr spawning over time. If successful, further artificial floating spawning nests could be added, as required, in future.

In addition, general best practice guidance and mitigation measures are also provided.

1 Introduction

Gavia Environmental Ltd. (GEL) was commissioned by Earba Ltd. (the client) to compile a species protection plan for Arctic charr (*Salvelinus alpinus*) in relation to a proposed long-scale, long duration 1800 MW pumped storage hydro scheme and associated infrastructure on Loch Earba and Loch Leamhain located on the Ardverikie Estate, Scottish Highlands.

Arctic charr are considered vulnerable in Scotland and are currently a UK Biodiversity Action Plan (UKBAP) fish species (JNCC, 2007). To ensure protection of Arctic charr during the construction and operational phases of the Earba Storage Scheme, a species protection plan (SPP) has been compiled. As a noted specialist in the ecology of Arctic charr, the advice and input of Prof. [redacted] of University of Glasgow's Scottish Centre for Ecology & the Natural Environment has been sought and adopted in the development of this species protection plan. A summary note prepared by [redacted]s detailing his considerations, and his expert opinion on potential mitigation options, is presented in Appendix E.

This document has been prepared in support of the Earba Pumped Storage Hydro scheme CAR Licence Report, Chapter 5, Aquatic Ecology and Appendix J Aquatic Ecology Technical Appendix for the CAR Licence, and should be read in tandem with them.

1.1 Proposed Development

The client is proposing to construct a new long-scale long, duration 1800 MW pumped storage hydro scheme and associated infrastructure on Lochan na h-Earba hereafter referred to as 'Loch Earba' and Loch a' Bhealaich Leamhain referred to as 'Loch Leamhain' located on the Ardverikie Estate (see Appendix A, 'Proposed Development' for Red Line Boundary of development). The Proposed Development would function by transferring water between a lower reservoir, Loch Earba, and an upper reservoir, Loch Leamhain. The maximum water level of both lochs would be increased by constructing dams to increase their natural water storage capacity, consequently a large area of currently peripheral habitat will be inundated (submerged in water) as shown in Appendix A. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

1.2 Assumptions and Limitations

Due to a lack of guidance on water quality parameters specific to Arctic charr, brown trout and salmon have been used as a proxy species where literature is available. Where this is used, this is highlighted. Atlantic salmon are known sensitive receptors of water pollution and as such their use as a proxy species likely overestimates the equivalent Arctic charr sensitivities. As such this approach is unlikely to compromise the validity of measures proposed in this SPP.

2 Legislation

2.1 Conservation Designation

Arctic charr are considered vulnerable in Scotland and are currently a UK Biodiversity Action Plan (UKBAP) fish species (JNCC, 2007). Arctic charr are also present as a priority species on the Lochaber catchment fisheries management plan. To ensure protection of Arctic charr during the construction and operational phases of the Earba Storage scheme, this species protection plan (SPP) has been compiled.

3 Methodology

3.1 Desk Study

A desk study was undertaken at the start of the commission. Information sources used for this study are described below:

- Bing Maps (2023) – to obtain aerial imagery to inform suitability of habitat;
- NatureScot SiteLink (2023) – to perform a search to identify relevant qualifying interests within 2 km of the development;
- NatureScot (2023) – to obtain information and legislation relating to fish in Scotland;
- National Biodiversity Network (NBN) Atlas (2023) - to search for publicly available information (available for commercial purposes) on protected species records within 2 km of the survey location, within the last 10 years;
- Joint Nature Conservation Committee (JNCC) (2024) – UK Biodiversity Action Plan;
- Lochaber Fisheries Trust (2008) – Lochaber catchment fisheries management plan;
- Highland Council (2021) – Highland Nature Biodiversity Action Plan 2021-2026;
- Earba Pumped Storage Hydro Scheme EIA Report, Chapter 11, Aquatic Ecology
- Earba Pumped Storage Hydro Scheme EIA Report, Appendix 11.1 – Aquatic Technical Appendix
- SEPA CAR Licence Application Report
- SEPA CAR Licence Application Report Appendix J Aquatic Ecology Technical Appendix for the CAR Licence Report

4 Desk Study Results

4.1 Designated Sites

No designated sites with Arctic charr as a qualifying feature are present within 20 km of the Proposed Development or present upstream in the catchment.

4.2 Arctic Charr Ecology

Arctic charr are a member of the salmonid family, closely related to both Atlantic salmon (*Salmo salar*), and Brown trout (*Salmo trutta*).

Habitat

Arctic charr are arctic relict species thriving in cold waters of predominantly deep lochs. Whilst anadromous Arctic charr are a feature in the northernmost part of their range (above 65 degrees latitude), all UK populations are freshwater residents.

Distribution

Geographical distribution within Scotland is wide with presence recorded in over 258 lochs, primarily concentrated in northern lochs (Adams and Maitland, 2018). The majority of populations occupy still waterbodies for their entire lifecycles, however, a small number are known to temporarily move to rivers to spawn (emerging fry migrate downstream and do not occupy rivers permanently).

Variation

High morphological variation displayed in Arctic charr are likely adaptations to ecological niches in their respective environments, and result in variances in life history strategies. Morphological variances described in literature include 'pelagic' morphs known to occupy the pelagic zone primarily feeding on zooplankton, 'benthic' morphs occupying deeper habitat and feeding on a range of benthic invertebrates and larger 'piscivorous' morphs feeding on fish.

Spawning

Spawning of Arctic charr typically occurs between autumn and early winter (September to January) (Walker, 2006). Arctic charr are known to spawn between autumn / late winter / early spring (Klemetsen et al., 2003). 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 Windemere); and <1.24 m (average of Irish loughs) (Frost, 1965). Specialist opinion from Professor Colin Adams indicates that Artic charr will ultimately avail of whatever water depth in which optimal spawning habitat is found. While some spawning site fidelity has been observed in Arctic charr, it is considered that habitat quality will be the overriding factor in most circumstances.

4.3 Previous Field Surveys

4.3.1 2023 Field Surveys

Aquatic survey work was first carried out between July and September 2023 (GEL, 2023) which indicated the suspected presence of Arctic charr in the Loch Earba (both basins) and Loch Leamhain.

Gill netting surveys were undertaken (under an appropriate license) on both basins of Loch Earba. A seven net night effort was achieved on both basins using pelagic and benthic net types, covering benthic and pelagic habitat types. Gill netting results indicated the presence of three species: Brown trout, Arctic charr and Eurasian minnow. Brown trout and Eurasian minnow were found in both basins of Loch Earba and Arctic charr were found only in the East basin. Arctic charr populations were determined to be in unfavourable condition due to their low occurrence during the gillnetting.

Based on the presence of Arctic charr in benthic nets located within the deepest loch areas in addition to morphometric traits/body size consistent with benthic feeders (pronounced rounded nose) in other Scottish lochs, it was assumed that Arctic charr present were a benthic morph.

The results of the electrofishing surveys (undertaken during July 2023) were inconclusive due to similarities of Arctic charr and brown trout at the fry life stage, and the time of year the electrofishing surveys were conducted where fish are less well developed. Therefore, the fry captured could not be definitively distinguished to species level. On review of a sample of photographs, Arctic charr fry in adjoining watercourses around the Proposed Development including the Allt Loch a' Bhealaich Leamhain (outflow of Loch Leamhain), Moy Burn, Allt Coire Pitridh / Allt Coire a' Chlachair were identified as possible Arctic charr but not with absolute confidence in identification. Under a precautionary approach, Arctic charr were therefore considered present in the Earba West Basin and Loch Leamhain until further survey works could determine presence / absence of the species.

Brown trout and Eurasian minnow (*Phoxinus phoxinus*) were also identified during gillnetting and electrofishing surveys during 2023, but are outside the scope of this species protection plan.

4.3.2 2024 Field Surveys

Further aquatic surveys were undertaken during 2024 to provide additional evidence and to reduce uncertainty on the presence and distribution of Arctic charr within the Proposed Development area.

Electrofishing surveys were undertaken during August 2024. No Arctic charr were identified during the 2024 survey. Independent external verification of the photographs was sought based on the fish catch from the 2024 surveys. None of the specimens examined could positively be identified as Arctic charr, notwithstanding the limitations of species-level identification of fry of less than 50mm length.

A comprehensive eDNA survey was undertaken during October 2024 utilising specialist external support from UHI's Institute of Biodiversity and Freshwater Conservation. This survey positively identified the presence of Arctic charr in Loch Earba (East basin only) and indicated the absence of Arctic charr in Loch Earba (West basin) and Loch Leamhain. The Arctic charr DNA identified in Loch Earba (East basin) was spatially sparse, and comprised a very low relative proportion of the total fish population present (<0.5% of total detected fish DNA).

Efforts were made to undertake a further gillnetting survey in 2024, and while a licence was ultimately granted, it was not possible to complete this activity before the closure of the relevant survey season. The subsequent emergence of the eDNA results (see above) further questioned the merit and ethical implications of undertaking this survey work given its widely recognised dis-benefits (up to 80% fish mortality estimated).

Based on all of the available results, it is considered that the following conclusions can be reached:

- Arctic charr are currently present in Loch Earba (East basin)
- Arctic charr are currently absent in Loch Earba (West basin)
- Arctic charr are currently absent in Loch Leamhain
- The Arctic charr population in Loch Earba (East basin) is most likely to be comprised of relatively low densities/numbers of a single morph of Arctic charr of benthic character.
- Arctic charr may be present in the inflowing tributaries of Loch Earba (West basin) and the outflowing tributary of Loch Leamhain, although there is uncertainty surrounding their presence based on available lines of evidence.

5 Consideration of Potential Mitigation Options

5.1 Background

Consideration of potential mitigation options for impacts on Arctic charr as a result of the Proposed Development has been undertaken taking account of engineering, ecological and hydrological considerations in accordance with available guidance and good practice.

A range of potential mitigation options has been considered with the objective of preserving (and where possible, enhancing) the genetic diversity represented by the small population of Arctic charr resident in Loch Earba East. Where possible, options which seek to preserve this population in-situ have been prioritised, but for completeness, options involving offsite measures have been included.

The views of a range of stakeholders have been taken into account in the development of the mitigation options considered.

Note: This section, and the mitigation options considered within, are specifically targeted towards consideration of impacts upon Arctic charr spawning within the lochs themselves. Additional mitigations targeting impacts upon potential spawning within the tributaries feeding the lochs is detailed in Section 6 below, and attached appendices, particularly **Appendix F**.

5.2 Impacts to be Mitigated

In considering available mitigation options, the likely impacts on the species are critical, as these are the aspects which any successful mitigation options must address. The identified likely impacts on Arctic charr in Loch Earba East are as follows:

1. Impact on future spawning success (due to loss of suitable habitat)
2. Impact on food availability (due to impacts on current food sources)

Given the existing population of Arctic charr is small (based on all available evidence), the significance of likely impact 2 (reduction in food availability) is considered as being less significant. This is due to a judgement that the current food availability is likely to be in excess of the needs of the current small population. The significance of likely impact 1 is considered high due to the significantly different and variable water levels envisaged as part of the Proposed Development. These effects are likely to have a significant effect on the currently available spawning habitat, which is already relatively limited (Earba Spawning Habitat Assessment Report, GEL (2024).

5.3 Specialist External Advice

Due to the limited body of evidence available on successful mitigation options for Arctic charr specifically, we have consulted directly with Professor Colin Adams, a noted species specialist, in developing a range of potential mitigation options. A summary of Professor Adams' advice, as presented to Gavia Environmental, is included in **Appendix E**.

5.4 Available Mitigation Options

Based on option development work undertaken by the developers of the Proposed Development, Gavia Environmental and Professor Adams, the following potential mitigation options have been identified to address likely impacts within the lochs:

A. Population translocation

B. Artificial floating spawning nests

C. Engineered spawning areas

A brief description of each mitigation option is presented below.

It should be noted that the Proposed Development envisages raising the minimum water level of Loch Earba East to such an extent that it would in future form a larger single loch comprised

of the current footprints of both Loch Earba East and Loch Earba West. As a result, it is anticipated that Arctic charr would have access to a much larger loch in future with potential for increased spawning habitat and food source potential over and above the current provision of the two separate lochs in their current condition.

5.4.1 Population Translocation

This option envisages the translocation of Arctic charr eggs from spawning grounds in Loch Earba East to an offsite receptor site which would remain unaffected by the Proposed Development. It would be necessary to locate active spawning locations within Loch Earba East, and the subsequent collection of adequate numbers of viable Arctic charr eggs from these locations to enable the establishment of a sustainable new population at the receptor site. An obvious prerequisite for this option would be the identification of an ecologically equivalent receptor site, and negotiating such a translocation proposal with a range of stakeholders. This option is likely to involve significant regulatory and stakeholder input prior to it being possible to execute. It is not guaranteed that a suitable receptor site could be located, nor that all required permissions would be forthcoming. It must be noted that there are also risks involved in the collection and transport of fish eggs, in that it may not be practically possible to collect, transport and deliver viable eggs from a sufficient number of individual specimens of the existing population (thereby protecting the complete genetic diversity of the population).

5.4.2 Artificial Floating Spawning Nests

This option envisages the creation of artificial replacement spawning gravels within beds suspended below a floating habitat 'island'. This option envisages the long term provision of optimal (albeit artificial) spawning habitat which is resistant to the effects of changing water levels (as the spawning redd would be suspended in a constant water depth independent of changing loch water levels). There is evidence of such habitats being successfully used by other fish species. However, despite there being anecdotal evidence of such habitats being provided for Arctic charr (for example, in Maine, USA), no published evidence as to the outcome or success of this (or other) attempts. Given the current paucity of evidence for the success of this option, it is not considered that this option alone would be adequate mitigation against the foreseeable impacts, however, there is considerable merit in trialling its use as part of an evidence gathering exercise to help supplement the evidence gap in future years. Were this option to prove particularly effective at Loch Earba, it is anticipated that additional artificial floating habitat could be provided in future.

If adopted, this option would additionally provide ecological and habitat enhancement for species other than Arctic charr, including macrophytes, macroinvertebrate communities and various birds via the installation of an upper tier at the loch surface which would feature macrophyte growth.

A schematic illustration of the layout of the proposed floating habitat is illustrated in **Appendix B**.

5.4.3 Engineered Spawning Areas

This option envisages the creation of engineered spawning areas which would be populated with optimal spawning gravels during the construction of the Proposed Development. These spawning beds would be situated such that they do not extend above the level of the minimum inundation level of the proposed PSH operation to ensure, as far as is possible, that any spawning use by Arctic charr (and other species) would not subsequently be threatened by aerial exposure. Further detailed engineering design would be required to inform this option, with particular regard paid to the risk of future fouling of the spawning gravels by suspended peat deposits and other suspended solids within the water column taking account of the proposed operational regime of the PSH scheme. It is anticipated that an ongoing maintenance infrastructure and regime would be required to sustain the suitability of the provided habitat over time. This could take the form of an embedded network of pipework to

enable the periodic flushing (outwith the spawning and egg development periods) of the spawning gravels, or the periodic use of craft-mounted vacuum extraction (calibrated to remove fine sediment without disturbing the spawning gravels themselves).

5.5 Discussion of Mitigation Options

Option A, population translocation offers the distinct advantage that once successfully executed, the future and ongoing viability of the translocated population and their distinct genetic character would be assured, as they would no longer be affected by the Proposed Development. This benefit obviously assumes that the identification of a receptor site and the translocation effort itself are carried out thoroughly and carefully.

A significant challenge posed by this option is that it requires collection of an adequate proportion of the total genetic diversity within the existing resident population. This challenged is heighted by the practical difficulties in locating and accurately identifying current Arctic charr spawning grounds which, while not the most likely outcome, may be situated in existing deep water environments.

Guidance exists on how to identify, select and assess the potential suitability of candidate receptor sites, however this process is not straightforward, and it is not guaranteed that a suitable candidate could be found. Various permissions and authorisations would be required, not least of which would be landowner permission, and again, it is not guaranteed that such permissions would ultimately be possible for the identified receptor site. Given the time and assessment effort required by this process, it may require an extended period to successfully identify a viable receptor site.

Expert opinion suggests that potential impact of the Proposed Development on the resident population in Loch Earba East is one of population reduction rather than complete extirpation.

While in some circumstances population translocation would be considered the most beneficial mitigation option possible, while viable, it is not considered the most logical option given the small size of the existing Arctic charr population in Loch Earba East. That is, the practical challenges and the impacts of the translocation operation itself may be such as to reduce the benefits of this option to such an extent that it was no longer optimal.

Option B offers several potential advantages in that is an engineered and modular solution, which can be optimised and scaled according to need, and changed and/or optimised over time. However, as noted above, while it has been successfully used for other fish species, we have been unable to find any documented examples of its successful use for Arctic charr specifically. As a result, we do not consider that this option, in isolation, can provide adequate mitigation against the likely impacts of the Proposed Development on Arctic charr with the required level of confidence.

Notwithstanding the fact that option B is unproven for Arctic charr, it is considered that there is significant scientific value in utilising the Proposed Development as an opportunity to test and investigate the viability of this option for both Arctic charr, and other species. Should such a trial prove to be successful in encouraging Arctic charr spawning, it is proposed that this option should be expanded (i.e. the provision of additional floating islands) in future years, if required, as part of the project's ongoing operation.

Option C also offers significant advantage in that it too can be scaled and optimised to provide ideal spawning habitat for Arctic charr (and other fish species). Expert opinion suggests that the availability of optimal spawning habitat conditions (i.e. irrespective of water depth) is the overriding factor in enabling successful spawning for Arctic charr. That is, Arctic charr will spawn in optimal habitat in deeper water where all available spawning habitat in shallow water is poor or sub-optimal. Therefore, it is believed that this option provides a very high likelihood of success in mitigating the impacts of the Proposed Development on Arctic charr.

The principal disadvantage of Option C is that it is vulnerable to suffocation/contamination of the introduced spawning gravels by an increase in suspended solids within the water column due to the future erosion of habitats in the margins of the existing loch footprints which are exclusively terrestrial at present due to their repeated inundation and exposure as a result of

the Proposed Development's operational regime. It should be noted that this issue will also potentially affect the existing natural optional spawning habitat over time through an increased in suspended solids within the water column. However, this impact may be somewhat mitigated over time by the creation of new cleanly washed gravels created by the increased wave action of the repeated water level cycling anticipated by the operation of the Proposed Development. It is likely that Option C would therefore require some programme of ongoing maintenance to sustain the spawning gravels in optimal condition over the longer term. The exact design of both the spawning beds themselves, and any attendant maintenance regime would require significant design, engineering and ongoing operational effort.

5.6 Proposed Mitigation Options

Based on the options considered above, and taking account of their various benefits and disbenefits, the following proposed mitigation options have been selected.

Primary Proposed Mitigation

It is proposed that Option C will form the primary mitigation against the likely impacts upon Arctic charr as a result of the Proposed Development.

This option has been selected as primary mitigation as it offers a very high likelihood of success. It can also be scaled and optimised precisely to the needs of the existing population and the project specific circumstances.

Secondary Proposed Mitigation

It is further proposed that a trial deployment of Option B be undertaken to further mitigate against the likely impacts upon Arctic charr as a result of the Proposed Development.

This option is proposed as it offers additional potential spawning habitat opportunities, can be optimised and scaled according to need, has broader potential ecological benefits, and due to the current absence of scientific evidence on the effectiveness of this option for Arctic charr specifically. It is anticipated that the initial deployment of this option would be delivered in conjunction with an appropriate independent academic study.

6 Protection Plan

6.1 General Mitigation Measures

The following generic mitigation procedures will be followed:

1. A toolbox talk should be given prior to construction to highlight necessary precautionary procedures and what signs to look out for (e.g. Arctic charr spawning, signs of fish in distress);
2. All works will be conducted away from the riverbank/marginal areas where this is a possible and reasonable accommodation;
3. SEPA pollution prevention guidelines (PPG5) (2007) will be implemented in all instances;
4. Adequate silt mitigation measures will be implemented where possible to reduce fine sediment or peat particles entering the lochs and/or watercourses;
5. No debris or construction material will be placed/disposed in the loch/watercourse and loose construction materials will be stored more than 50m away from the water's edge to reduce the introduction of fine material to loch/watercourses;
6. Plant and equipment washings will take place offsite on a designated area of hard standing at least 10 m from any watercourse or surface water drain;
7. Biodegradable oils will be used for all vehicles and plants where possible;
8. Plant will not be refuelled within 50 m of any loch/watercourse;
9. Fuel for plant will be contained within a double bunded fuel tank with appropriate sized spill tray or mobile fuel unit with an appropriate spill kits;
10. Spill kits will be available on site for the duration of works and within each construction vehicle;
11. Plant and machinery used will be checked for drips/leaks prior to arriving at site and checked frequently while in use. Spill kits/drip trays will be installed under each vehicle while parked overnight;
12. Fuel, oil and chemical facilities will be located on impermeable surfaces within controlled drainage and more than 50 m away from any loch/watercourse;
13. Fuel tanks will be clearly labelled with storage capacity to reduce risk of overfilling and spillage;
14. Oils stored in barrels from which small quantities will require transfer to other containers prior to use will have a tap fitted to the barrel. This will be stored on its side, on a stand, within a bunded area;
15. A drip tray will be placed under taps to prevent drips and leaks entering the environment;
16. Water based or low solvent trade materials(sealants, coatings, adhesives and glazings) will be used where possible, and contained within a secure storage device; and
17. Construction workers will be aware of the Scotland incident hotline number 0800 807060 that should be called to report any environmental incidents. Incidents include spillages, contaminated surface water run-off, flooding, damage to habitats and poor waste disposal and storage.
18. These measures are non-exhaustive and should not be solely relied on. Further pollution prevention measures will be outlined in the Construction Environmental Management Document (CEMD)and associated documents.

6.2 Specific Mitigation Measures

Mitigation During Construction

1. Best practice guidance, in line with the relevant SEPA Pollution Prevention Guidelines (PPGs), will be maintained in order to minimise the likelihood of changes to water quality or chemistry through sedimentation or spills during construction which could affect Arctic charr;
2. Water quality parameters relevant to Arctic charr will be monitored in-situ by a suitably experienced Ecological Clerk of Works (ECoW) throughout the construction period, where measured results exceed survivable limits, affected works should halt temporarily. Relevant water quality parameters to Arctic charr are provided in Appendix D (water quality parameters);
3. Instream works will be minimised, where practical, during sensitive spawning and localised migration periods for Arctic charr (and other fish). Sensitive periods are October – May to cover salmonid spawning, egg development in gravels and hatching. Arctic charr spawning periods are location dependent but typically occur between September to January (spawning preferences in Loch Earba (East basin) are currently unknown). 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 at the discretion of the ECoW;
4. Prior to the construction of the Shuas dam, the Pitridh aqueduct will be operational and this would provide fish passage to the upper Pitridh and tributaries along with spawning substrate within the aqueduct itself;
5. For the installation of any culverts, fish rescue and relocations will be taken prior to the damming / dewatering of the watercourse. This will protect any Arctic charr populations (and other species) in the vicinity of the works from harm;
6. In line with Marine Scotland guidance for the 'monitoring of watercourses in relation to onshore wind farm developments: generic monitoring programme'[1], the following monitoring measures are to be employed (as described below). Guidance specific to large pumped storage hydro schemes does not exist and it is considered that pollution pathways will be similar, thus the guidance is applicable to the Proposed Development.
    a. To develop a reasonable baseline dataset from which to detect change it is important that water sampling takes place during construction and for a period of at least a year after construction. Sampling will 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 will occur more frequently and can be undertaken in-situ by the ECoW.
    b. Ex-situ water analysis will 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 (µeq l-1), acid neutralising capacity (µeq 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 will occur pre-construction to provide a robust dataset and monthly during

[1] 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/

construction to ensure water quality is consistent with the requirements of Arctic charr.

c. Regular visual inspections of all watercourses and loch margins (flow conditions, discolouration, collection of debris, fish in distress/floating) will be presented in a monthly summary water quality report and advised by an independent suitably qualified ECoW. These will detail any potential adverse impacts on Arctic charr and propose suitable mitigation measures where possible and/or appropriate.

d. An appropriate programme of electrofishing will be implemented to monitor fish spawning success and population densities during the construction period, and during the first years of the scheme's operation. Surveys will be fully-quantitative and include at least one control site, where possible. Surveys will be conducted late in the survey season to allow brown trout and Arctic charr fry to be differentiated.

7. Any lighting used during construction will be directed away from the loch edges and watercourses to prevent the risk of increased predation of fish during the hours of darkness. Although Arctic charr are unlikely to occupy marginal areas during the day, they are known to display diurnal vertical migration and thus may be present in the upper water column for short periods during the night where they are placed at greater risk of predators, such as otter;

8. Any piling operations will adopt a 'soft start' approach to allow adult fish within the immediate vicinity of the cofferdam works area to disperse unharmed. The ECoW will monitor loch areas in the vicinity of the works for any fish kills, notably Arctic charr, in relation to works producing underwater noise;

9. Subject to regulatory approval, the identified mitigation options in Section 5.6 above will be implemented in accordance with a documented species mitigation plan, following detailed design of the selected mitigation options.

Mitigation During Operation

Following completion of the Proposed Development, Loch Earba will at all times (i.e. even during minimum inundation) be a single water body rather than as currently, two separate basins (with intra-basin migration currently considered impractical). Therefore, the proposed mitigations during operation will in future apply equally to the combined water body. This offers the potential to expand the range of Arctic charr confirmed to be present in Loch Earba East Basin to Loch Earba West Basin, with the potential to make use of the spawning habitat creation measures described in 11 and 12 below.

Tributary mitigations

10. Riparian planting would occur along watercourses not affected by inundation levels (in tandem with peat restoration works). Areas of planting will be guided by existing peat depths and suitable terrain. This would aid in improving instream habitat quality (notably Arctic charr spawning) by providing instream and bankside cover for fish and would aid in preventing water temperature increases. This would additionally provide cooler inflowing water which will aid in buffering water temperature increases, notably in light of future predicted baselines. Information specific to riparian planting is provided in a separate biodiversity enhancement plan.

11. In the event that Arctic charr at Earba are or become river spawning, spawning habitat creation on the Pitridh aqueduct and Moy burn higher than inundation levels, and thus unaffected by water level fluctuations, would provide spawning habitat in excess of what is lost. At the Moy Burn the risk of introduced spawning gravels being washed out of the watercourses by spate events will be reduced by including a short diversion channel 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 will be 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). Spawning channels are an established tool in North America for both conservation and commercial rearing of vulnerable salmon stocks. Evidence indicates egg-to-fry survival rates can increase up to 10-fold in spawning channels compared to survival in the adjacent, natural streams. Examples are discussed in **Appendix C**. 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. It is proposed that substrate is extracted on site from the dry river bed from previous diversion of the Moy Burn. This would ensure substrate is similar in size and geology to that of the Moy Burn and reduces the emissions associated with importing substrate. The Moy burn habitat proposal is shown on GEL Figures 2.44.1 and 2.44.2, as presented within **Appendix F**. Detailed designs would be subject to approval by NatureScot and SEPA.

12. 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, if river spawning now or in the future, and brown trout will be able to access the aqueduct channel during all water levels. Additionally, upper sections of the aqueduct (upper straight sections) will be designed in a manner to contain optimal spawning substrate in line with that proposed in **Appendix C**. The aqueduct is designed with two parts a lower effective discharge channel which will have constant flow and a higher overflow channel which will act as a floodplain. The effective discharge channel will contain a step pool system to retain substrate. This will improve on spawning habitat lost to the dam construction and inundation levels; there are no likely predicted impacts on water quality. Refer to Figures 2.21.1 to 2.21.3 as presented within **Appendix F** for further details of the Pitridh aqueduct.

Loch spawning habitat mitigations

13. Loch spawning habitat would be provided by the installation and maintenance of engineered spawning areas situated to ensure they are permanently below the minimum inundation level of the combined loch. While further consideration and detailed design is required, it is thought these may be best located in the area of the current Moy delta. These 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. A maintenance regime to ensure the engineered spawning habitats continue to offer optimal spawning habitat in the long term. This regime may include an embedded network of pipes to allow periodic gravel flushing (outwith the spawning/egg development periods) or periodic low-pressure vacuum cleaning to remove any fine sediment (principally peaty solids) without disturbing the spawning gravels (again, only to be undertaken outwith sensitive periods). Detailed design drawings and maintenance proposals will be provided once agreed and fully developed.

14. Due to scientific uncertainty, artificial floating spawning nests would be installed into Loch Earba, on a trial basis as part of an independent academic study. 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 or other flotation devices at a constant depth to maintain a favourable depth at around 1-2 m in depth. Structures may be deployed at variable depths to cover a range of preferences and/or inform success of mitigation at different depths for incorporation in future PSH mitigation. 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. Substrate will be used from affected draw down zone to minimise differences to current spawning grounds and match size and geological composition. The specific measures proposed would be novel in design, however, suspended spawning

substrate, e.g. Kiddle spawning grounds[2] are recognised as an established mitigation measure (for other fish species). This will additionally provide suitable conditions for macrophyte and macroinvertebrate communities to establish, thereby offering additional ecological benefit. It is proposed monitoring would be undertaken (in-situ or ex-situ) and results made publicly available for use and/or to inform mitigation design on other large PSH. Example designs for the proposed artificial floating spawning nests is provided in **Appendix B**. The designs are not final and outline a potential design only. Final designs and specifications will be subject to approval by NatureScot and SEPA. If proven successful for Arctic charr, additional floating nests could be added, as required.

15. Water quality monitoring post-construction and during the first year of operation would be conducted in line with Marine Scotland guidance[3] as stipulated in Section 11.9.6. In-situ sondes and/or dataloggers with data telemetry units can be installed to provide long term real time data if required by NatureScot and/or SEPA.

[2] Marenkov, O. and Fedonenko, O. (2016) Ways of optimization of breeding conditions of fish by using artificial spawning grounds. World Scientific News.
[3] 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/

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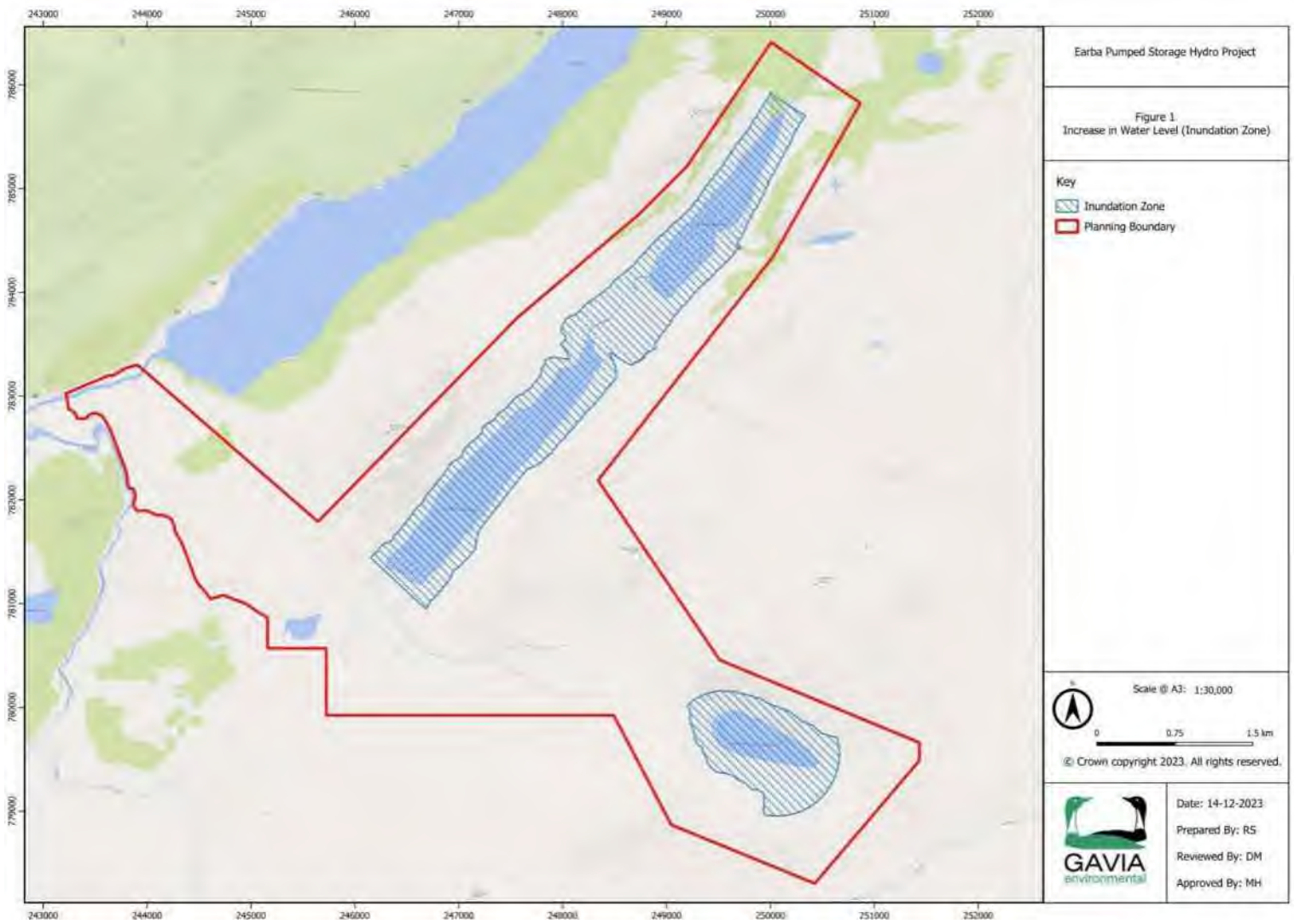
Appendices

Appendix A Proposed Development



Appendix B Artificial Floating Spawning Nest Schematic

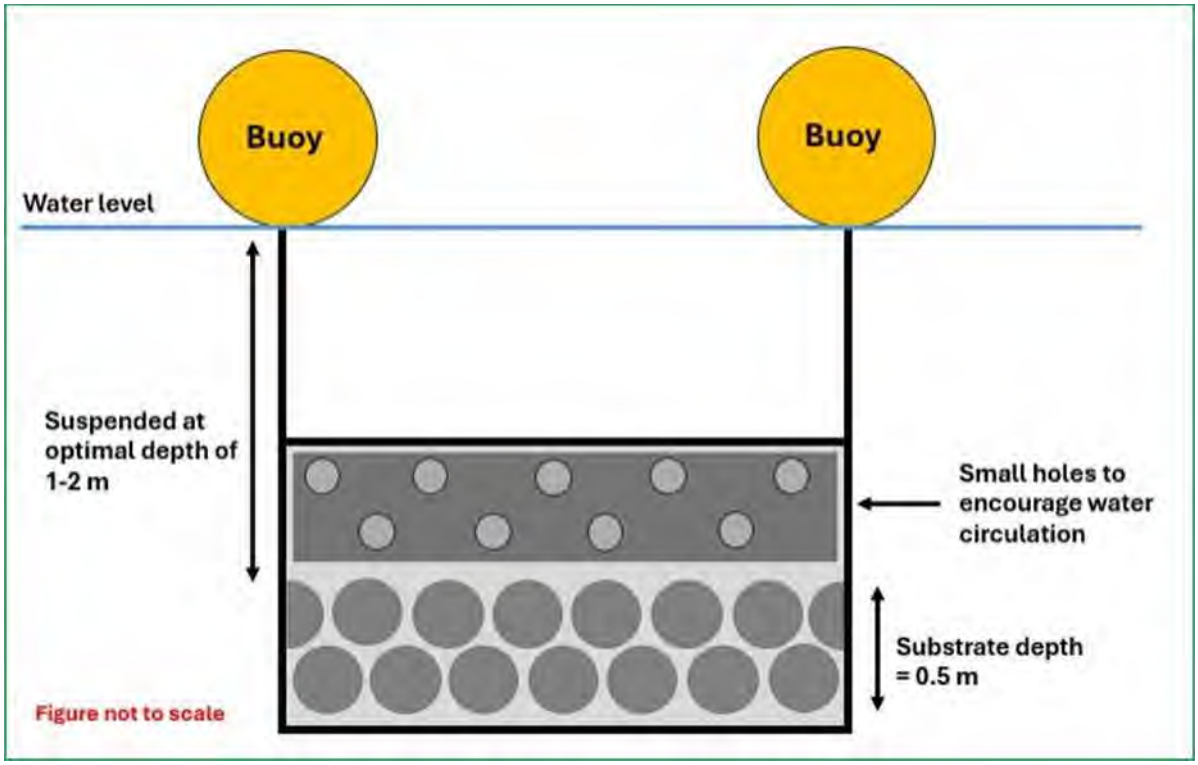


Figure 2. Cross-section of a proposed design for the artificial floating spawning nests

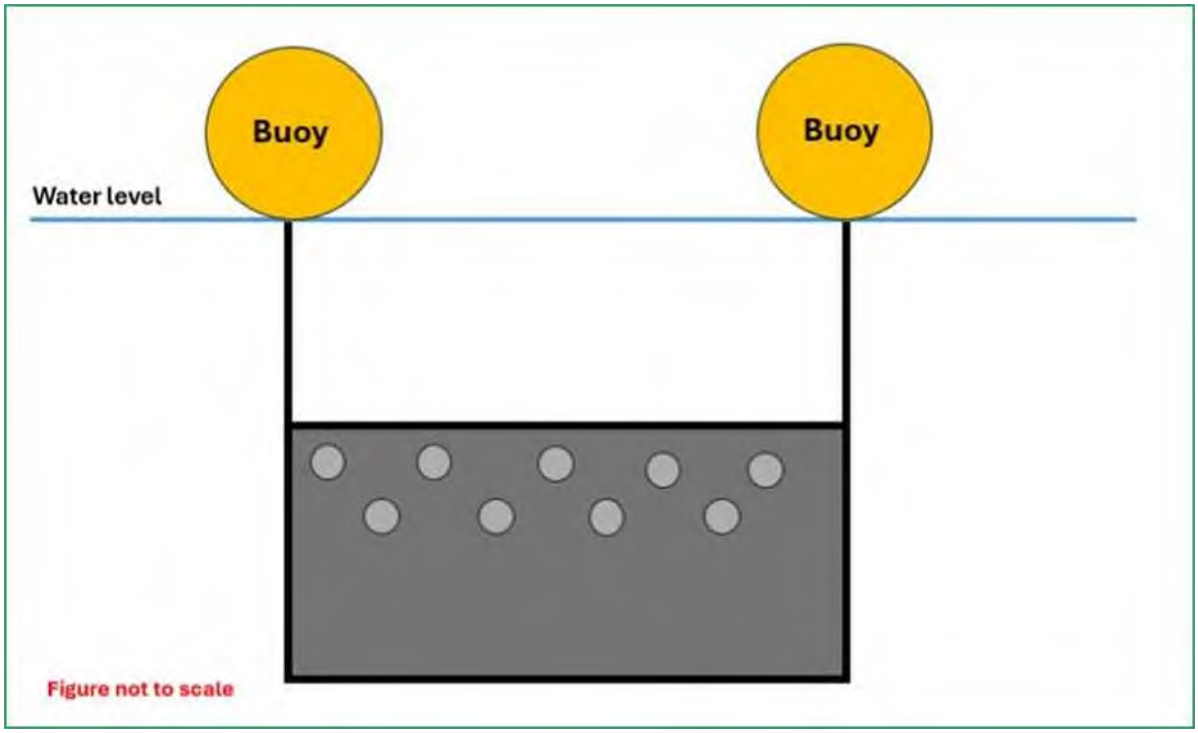


Figure 3. Side profile of proposed design for the artificial floating spawning nests

Figure 4. Potential Two-Tier Design with floating macrophyte beds and spawning substrate suspended below (Image Provided by Biomatrix)

Appendix C Spawning Channels Examples and Proposals

Example	Photograph	Information
Weaver Creek Spawning Channel (West, 2023)		Weaver creek spawning channel is located within the lower Fraser River System, Canada. This features a 3 km stretch of spawning channel with design of depth and velocity of the channel based on observations of preferential spawning downstream. Margins of the channel are armoured with larger cobbles and boulders, and riparian planting, to provide channel stability and limit Between 2013-2023 egg-to-fry survival increased an average of 56%. **Elements to incorporate to the Earba PSH:** Substrate in the Moy Burn, suitable for the spawning of Arctic charr could be mimicked in a diversion channel. A large volume of dry riverine substrate is present in the channel previously diverted. The majority of this substrate is due to be lost by inundation levels, consequently re-use on site would mimic geology (and consequently water chemistry) and substrate requirements of the Moy Burn whilst negating the need for external sourcing. Riparian planting is currently being proposed under the biodiversity enhancement plan and would work in tandem within artificial spawning channels.

Example	Photograph	Information
Gates Creek Spawning Channel (Northern St'at'imc Fisheries, 2009)	 Gates creek spawning channel during construction before water was re-diverted.	Gates creek spawning channel is 1584 m long x 6 m wide with an estimated volume of 4500 m3 of gravel present. The river lies upstream of Anderson Lake, Canada. Initial survivability ranged from 40-80% (before decrease pre regrading). The channel featured a polyethylene liner to prevent leakage and a diesel generated pump to prevent the formation of frazzle ice. Construction methodologies, including post-construction modifications are available in Northern St'at'imc Fisheries (2009). **Elements to incorporate to the Earba PSH:** Substrate was extracted from the main channel, a total volume of 360 m3, supplemented with 680 m3 of new graded gravel. Instead of extracting substrate from the Moy Burn repurposing substrate from the adjacent dry water channel would prevent adverse effect to the Moy Burn. The channel was re-graded to increase slope to promote self-cleaning of gravel and reduce maintenance, such elements could be considering in designs.

Example	Photograph	Information
Nadina River Spawning Channel (Northern St'at'imc Fisheries, 2009)	 Spawning channel network, dry at the time of picture.	Nadina river spawning channel is 3 km in length with a capacity of 20, 000 adult salmon and produced on average 6 million fry per year. The channel is lake fed with a surface and secondary pipeline at 9.14 m deep, drawing cooler water for temperature control. **Elements to incorporate to the Earba PSH**: The Nadina river spawning channel was built due to limited existing spawning areas and unfavourable environmental conditions, similar to the existing conditions in Loch Earba (depleted littoral zone, fluctuating water levels, limited in-stream spawning opportunities). Expanding on existing spawning availability in excess of the existing availability provides an opportunity for the population to increase. The channel initially used a weir to direct adults into the artificial channel to improve use. Design of the channel could include the use of existing impassable barriers on the Moy Burn to direct fish to prevent the need of an artificial barrier. Length (3 km) is in excess of the length required for Loch Earba to compensate for lost habitat.

Example	Photograph	Information
Babine Lake Development Project	 Fulton River Spawning Channel 2, Babine Lake.	Two tributaries of the Babine Lake, the Fulton River and the Pinkut Creek were selected to develop spawning channels and river flow control works, known collectively as the 'Babine Lake Development Project'. **Elements to incorporate to the Earba PSH:** The Babine Lake provides a similar case study to Loch Earba in that the existing lake (loch) is depleted following extenuating environmental conditions with conservation effort focused on tributaries and not the lake itself.
Nekite River Spawning Channel (Northern St'at'imc Fisheries, 2009)	N/A	This is a smaller-scale un-manned spawning channel to align with tighter budgetary restrictions. This provides an example of a low maintenances pawning channel on a high energy catchment prone to flooding. **Elements to incorporate to the Earba PSH**: High energy periods are similar to the Moy Burn that experiences regular spate events. Initial concerns over siltation post-spate events affecting survival was combated by period checks post-event and gravel cleaning, if required. Siltation is unlikely to be a limiting factor on the Moy Burn given the limited size of the catchment.

Example	Photograph	Information
Rodley Weir Bypass Channel (Wild trout. 2018)	 Rodley weir bypass in use	The Rodley weir bypass channel is purpose built to facilitate salmonid and fish movement on the River Aire. The channel was approximately 150 m long with an average slope of 0.688°. Although not functioning as an artificial spawning channel, the channel provides an example of successful small scale channel creation in the UK. Research using PIT tags in salmonids confirmed use of the channel. **Elements to incorporate to the Earba PSH:** The channels incorporated areas of shelter to reduce any increased predation risk associated with the habitat. This also provided areas of flow refuge were individuals may rest in heavier spate events or low flow conditions.

Appendix D Water Quality Parameters

Values are derived from aquaculture industries as optimal thresholds. In some cases, wild Arctic charr may be able to survive outside of these values, and have been suggested to have greater plasticity than farmed counterparts. However, considering the high conservation value of the species, optimal thresholds should provide useful guidelines for target water quality parameters.

	Parameter	Optimal Values	Notes
In-situ	Temperature	6 – 15 °C	Egg production 2-7 °C, >23 °C = Lethal
	pH	6.5 – 8.5	5 – 9 outer limits
	Dissolved Oxygen	<6.5 mg/L	65% saturation, or 70% for fry
	Salinity	<7 ppt	
	Total Dissolved Solids	<400 mg/L	
	Total Suspended Solids	<80 mg/L	May tolerate higher
	Alkalinity	20 – 400 mg/L	
Ex-situ	Aluminium	< 0.01	
	Ammonia -N (NH3 + NH4)	< 2.0	
	Ammonia (NH3)	< 0.015	< 0.005 in hard water
	Arsenic	< 0.05	
	Barium	< 5.0	
	Cadmium	<0.004	< 0.003 in hard water
	Calcium	20 – 60	
	Carbon dioxide	<5.0	< 10.0 in hard water
	Chlorine	<0.003	
	Chromium	< 0.03	
	Copper	< 0.006	< 0.03 in hard water
	Fluorine	< 0.5	
	Hydrogen cyanide	< 0.005	
	Hydrogen sulphide	< 0.002	
	Iron	< 0.1	
	Lead	< 0.02	
	Magnesium	< 15.0	
	Manganese	< 0.01	
	Mercury	< 0.0002	
	Nickel	< 0.01	
	Nitrate	< 1.0	
	Nitrite	< 0.015	< 0.1 in hard water
	Nitrogen	< 103% saturation	
	PCBs	< 0.002	
	Potassium	< 5.0	
	Selenium	< 0.01	
	Silver	< 0.003	
	Sodium	< 75.0	
	Sulphur	<1.0	
	Sulphate	< 50.0	
	Uranium	< 0.1	
	Vanadium	< 0.1	
	Zinc	< 0.005	
	Zirconium	< 0.1	

Appendix E Summary note on mitigations from Professor Colin Adams

Lochan na h-Earba Pumped Storage Hydroscheme:

Summary of the status and mitigation of impact upon Arctic charr

[redacted], University of Glasgow

9th December 2024.

Background

This short note provides a view on the proposed Earba Pumped Storage Hydroscheme in relation to the Arctic charr *Salvelinus alpinus*. This view has been informed by a review of the documents listed in Appendix 1 and specialist knowledge of this species. I address four principal questions:

1. What is the status of Arctic charr in the development area?
2. What are the major potential impacts upon that species?
3. What mitigations measures are possible?
4. Which mitigation is the most likely to be appropriate for this species at this site?

1. What is the status of Arctic charr in the development area?

There is a population of Arctic charr in the development area. With both eDNA detection and specimens collected, the evidence for this unequivocal. Although recorded elsewhere in the catchment, Lochs Laggan Treig and Lochy, this is a population that was previously unrecorded scientifically.

The population is certainly extant in the eastern Lochan nah-Earba (hereafter Earba) (specimens of unequivocal identity collected by gill netting and the species detected in eDNA water samples).

The evidence for a population in the western Loch Earba appears contradictory. Small specimens (<50mm) were collected from a stream draining into west Earba, identified as Arctic charr visually but not confirmed by genetic analysis. Visual identification can be difficult in very small specimens of Arctic charr thus this record must be treated with some caution. eDNA analysis of water samples from western Loch Earba did not detect Arctic charr, despite a robust sampling strategy, indicates a relatively high probability that Arctic charr are not extant in this basin.

A small specimen of Arctic charr was detected during electrofishing of an outflowing stream of Loch a'Bhealaich Leamhain (hereafter Loch Leamhain). The species was not detected in eDNA sampling of the loch itself. The stream specimen was small enough for identification to be uncertain. The relatively robust nature of the eDNA approach to sampling strongly suggests that the species is absent from Loch Leamhain.

The most likely conclusion from existing data is that the population in east Loch Earba is small. The combination of low eDNA read rate for this species, low capture rate in gill netting and a low estimated density from hydroacoustic surveys points strongly to this conclusion.

If west Loch Earba does support a charr population (the probability of this is low) then the gill net sampling and eDNA data indicate that it is a very small population.

The potential that Loch Earba supports multiple morphs of Arctic charr, as is known from other sites in Scotland (e.g. Lochs Rannoch, Awe, Dughail, Ericht) cannot be determined from the data collected from this site to-date. Morphs cannot (yet) be separated by eDNA techniques. Morph detection would require traditional sampling to collect a sample large enough to detect morphs (gill netting being the only realistic methodology for this site). This destructive technique would be detrimental to the population, which is likely of small size (see more below).

2. *What are the major potential impacts upon that species?*

Supporting documents clearly identify the potential impacts of the development to Arctic charr. These are:

a) Impact on future spawning success. This effect resulting from the potential for egg laying in littoral areas that are subsequently dewatered.
b) Impact on food availability. This effect resulting from reduced littoral benthic invertebrate production.

The effect of b) is, in my view, of low potential impact. This is in part because the charr population is small in size; because charr predominantly feed upon plankton (which will be less impacted by littoral dewatering) and because the proposed development will open west Loch Earba to foraging for charr.

The quantitative effect of a) - dewatering of spawning areas - is likely of considerably greater impact on the charr population. The risk is that at higher water levels during the breeding season, littoral spawning charr will lay eggs in shallow water areas that are subsequently dewatered resulting in egg mortality. Suitable spawning substrate for charr comprises washed gravel to cobble substrate sizes, free from high levels of small silt particles (which result in egg suffocation). Currently the availability of such substrate is limited to a discrete depth zone around both Earba lochs. The high frequency of water level change proposed by the pump storage scheme is will ultimately extend the depth range of high quality spawning substrate within a few years of the scheme operation (as wave action at depths which currently comprise high proportions of silt substrate, acts to wash light particle sizes into even deeper water). The risk however occurs from the potential for some fish spawning in high quality spawning substrate that is later exposed before incubation is complete.

3. *What mitigations measures are possible?*

The Earba Arctic Charr Protection Plan (P24105) identifies three potential mitigations for the impact upon spawning success.

i. *Translocation:* where a new Arctic charr population is created using Loch Earba broodstock at a new site (a receptor site) which will remain un-impacted by this development.
ii. *Artificial Floating Spawning Nests:* where suitable spawning for Arctic charr is provided in the form of a submerged spawning area the depth of which is constantly maintained by flotation ensuring that artificial spawning area is at a fixed depth below water at all times.
iii. *Engineered spawning areas:* where suitable spawning areas are provided in the littoral zone at depths below the drawdown zone of the completed development.

4. *Which mitigation is the most likely to be appropriate for this species at this site?*

i. *Translocation:* Translocations have been used as a conservation measure for high conservation value fish species including Arctic charr and Coregonids in the past. The principles are simple; establish a new population of the threatened one, at a new site where those threats do not apply; capturing and conserving the diversity that is embedded in the donor population. This mitigation thus avoids any developmental impact at the translocation donor site, the site under development. The International Union for the Conservation of Nature (IUCN) and Scottish Government have published conservation translocation guidelines and any translocation requires a licence in the UK. Successful application for such a licence would need to demonstrate adherence to the guidance. The fundamentals of the process are theoretically simple. The major difficulties are twofold:

a) Identifying a suitable donor site: both IUCN and Scottish Government guidelines identifies a number of criteria that the site chosen to establish the new population must meet. These include criteria for meeting the ecological needs of the translocated species, the future safety of the establishing population and the avoidance of ecological damage to the receiving site. These are relatively exacting and the experience of the use of this technique elsewhere in Scotland is that locating such a site is likely to be difficult and take some time.

b) Collecting sufficient eggs, juveniles or adults from the donor site to make a successful translocation. One principle of this mitigation methodology is that the translocation needs to capture a large component part of the donor gene pool. This requires collection of a sufficient number of individuals from the donor population. This creates a risk where the donor population is small, as seems to be the case in Earba. The assessed risks of the Earba development centre around those that may impact population size rather than those that result directly in extirpation. Translocation is certainly a viable option, however, the combination of the risk of failure of the technique (through failure to find an appropriate translocation site, failure to capture enough individuals at the donor site to represent the complete gene pool or the failure of the new population to establish a self-sustaining population) in addition to the likely worst impact of the development (a partial loss of spawning success) makes this a higher risk mitigation option. In my view not the preferred option.

ii. *Artificial Floating Spawning Nests.* To avoid the effects of reduced spawning success resulting from dewatering of spawning areas, providing access to spawning substrate that moves with changing water level and thus is constantly available at all water levels in Loch Earba is conceptually appealing. In addition to this, these structures would certainly provide beneficial habitat for other aquatic organisms in Loch Earba. There are however a number of negatives for adopting this as a strategy to support charr spawning:

I) Natural littoral spawning areas will remain extant and floating spawning nests would only represent a small proportion of the total spawning available at any time. However the natural spawning where it exists will attract spawning fish but would be subject to dewatering if it is within the drawdown zone.

II) There are no scientifically documented examples of Arctic charr using such systems. Thus, we do not know if they will be able to identify floating nest areas and will ultimately make use of them. Here the main risk is that although providing optimal spawning

substrate, because of their position (suspended) and the superstructure required to maintain position, Arctic charr simply may not recognise these as spawning sites.

III) Floating nests are highly engineered structures and will require continued maintenance to retain their integrity.

Taking a broader view of the use of this technology for future pump storage developments where drawdown regimes are likely to impact upon spawning habitat for Arctic charr, there is an opportunity to test the utility of this type of mitigation at this site. This would require development of a plan to install a suitable number of such devices and to monitor their use by Arctic charr and their ultimate spawning success. This would make an exceptionally valuable contribution to our understanding of future mitigation needs.

Despite this, such an undertaking would represent a trial and not a reliable mitigation for Loch Earba Arctic charr alone.

iii. *Managed artificial spawning areas:* Creating artificial spawning areas in deeper water beyond the drawdown depth of pump storage operation would provide mitigation against loss of spawning areas in a number of ways. In the short term, elevation of the water level in Loch Earba (both east and west) and operation of the pump storage scheme is very likely to significantly modify the availability and location of high quality spawning area available. As water level is raised, inundation of what is now terrestrial habitat will cause release of fine sediments into the loch. These will deposit on currently suitable spawning sites for Arctic charr making them unsuitable. In the medium term, spawning habitat in the (new) littoral will develop from the result of wave action scouring fine sediments. This will also occur in deeper water at lower water levels resulting in a greater depth range of suitable spawning substrates than currently exists. However, following the development of this new spawning habitat, drawdown during the operation of the pump storage scheme will mean that eggs deposited in suitable spawning substrates within the drawdown zone, risk drying out during incubation resulting in egg mortality.

What is proposed is the provision of actively managed, high quality spawning substrate located at depths that are below the lowest drawdown of the development following completion. These areas will be fitted with a mechanism to enable flushing of the substrate of the very small particle size silts that are most damaging for successful spawning. It is envisaged that flushing will comprise either a permanently located sub-bed water jet system that will allow for periodic substrate flushing from a shore-based pump system, or a vessel mounted vacuum dredger that will access the spawning areas during low water levels to remove silts by light suction.

The advantage of this mitigation is that it will provide optimal spawning and incubation substrates at a depth below the drawdown zone. Its integrity can be maintaining during the period of rapid change in loch levels which will likely result in considerable substrate release into the loch (from the inundated shoreline) and it will be able to retain high quality spawning areas in the event that wave action at low water levels post-development is insufficient in any year to resuspend light sediments from areas deeper than the lowest water levels.

The negative element of this as a mitigation is that it is likely that a proportion of the population may continue to spawn in good quality spawning areas that are within the

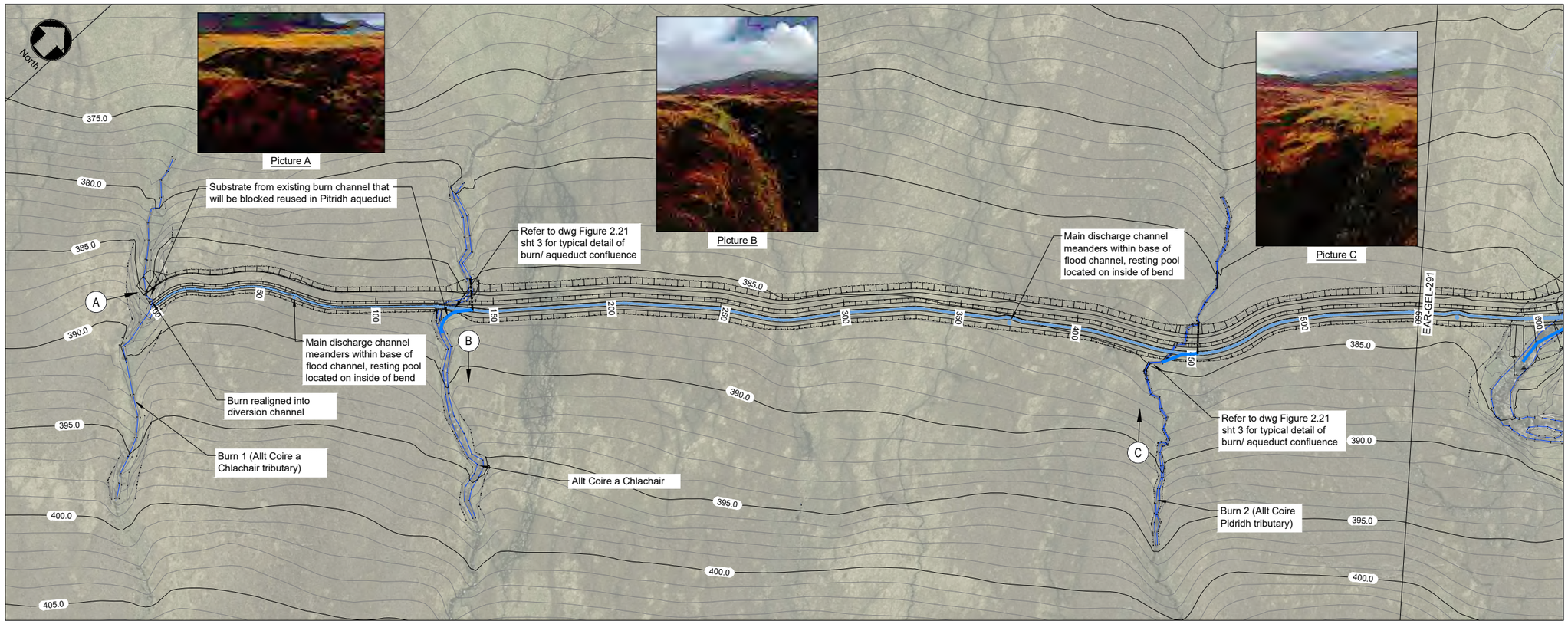
drawdown zone and thus are subsequently dried. Thus provision of a suitable quantity of such managed habitat and a robust management regime to ensure its enduring quality is essential.

It is this mitigation that is, in my view, the most likely to be effective as a mitigation measure.

Appendix 1 a list of documents provided through Gavia Environmental reviewed.

- Aquatic Ecology EIAR Survey Appendix
- Draft CAR Licence; Briefing Note
- CAR Licence Report
- 2024 Electrofishing Survey Report
- 2024 Earba Spawning Habitat Survey Report
- 2024 eDNA Survey Preliminary Report
- Hydromorphology Report
- CAR Application Drawings
- Arctic charr species protection plan
- Spawning Habitat Mitigation Note
- Information on Floating Habitats
- Map of Earba
- Photos of fish from surveys

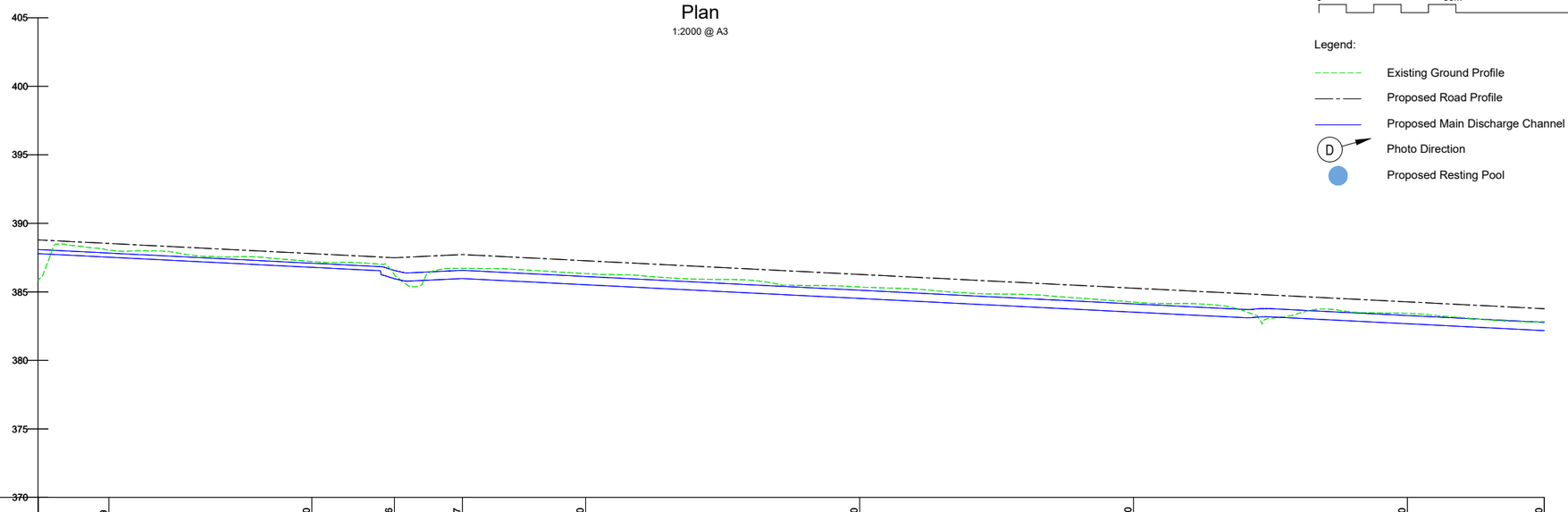
Appendix F Pitridh and Moy Channels Mitigation Design Drawings



Plan
1:2000 @ A3

0 50m 100m

Legend:
- Existing Ground Profile
- Proposed Road Profile
- Proposed Main Discharge Channel Profile
- D — Photo Direction
- Proposed Resting Pool



LONGITUDINAL SECTION

(A-DIVERSION CHANNEL)

CHAINAGE: 0 TO 550
SCALE: H 1:1000, V 1:200

Chainage	0.000	25.899	100.000	130.136	154.987	200.000	300.000	400.000	500.000	550.000
Existing Levels	385.885	388.050	387.214	386.255	386.721	386.336	385.354	384.255	383.432	382.818
Proposed Levels	388.791	388.532	387.791	387.490	387.722	387.271	386.271	385.271	384.271	383.771
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 1 1:100				Section 2 1:100				Section 3 1:100	

0 50m 100m

IF IN DOUBT - ASK

NOTES

Aqueduct Notes

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Bridge Notes

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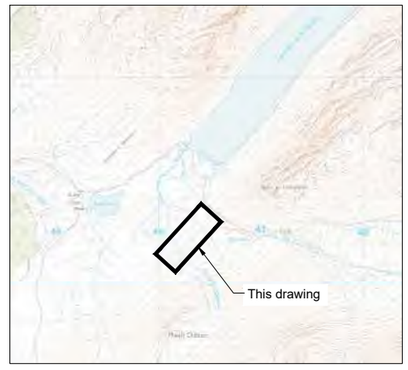

Location Plan
1:30,000 @ A1

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	x	MW	CAR LICENCE SUBMISSION 13/11/24	DT	GRM
P1	02.02.24	MW	FOR PLANNING	DT	GRM

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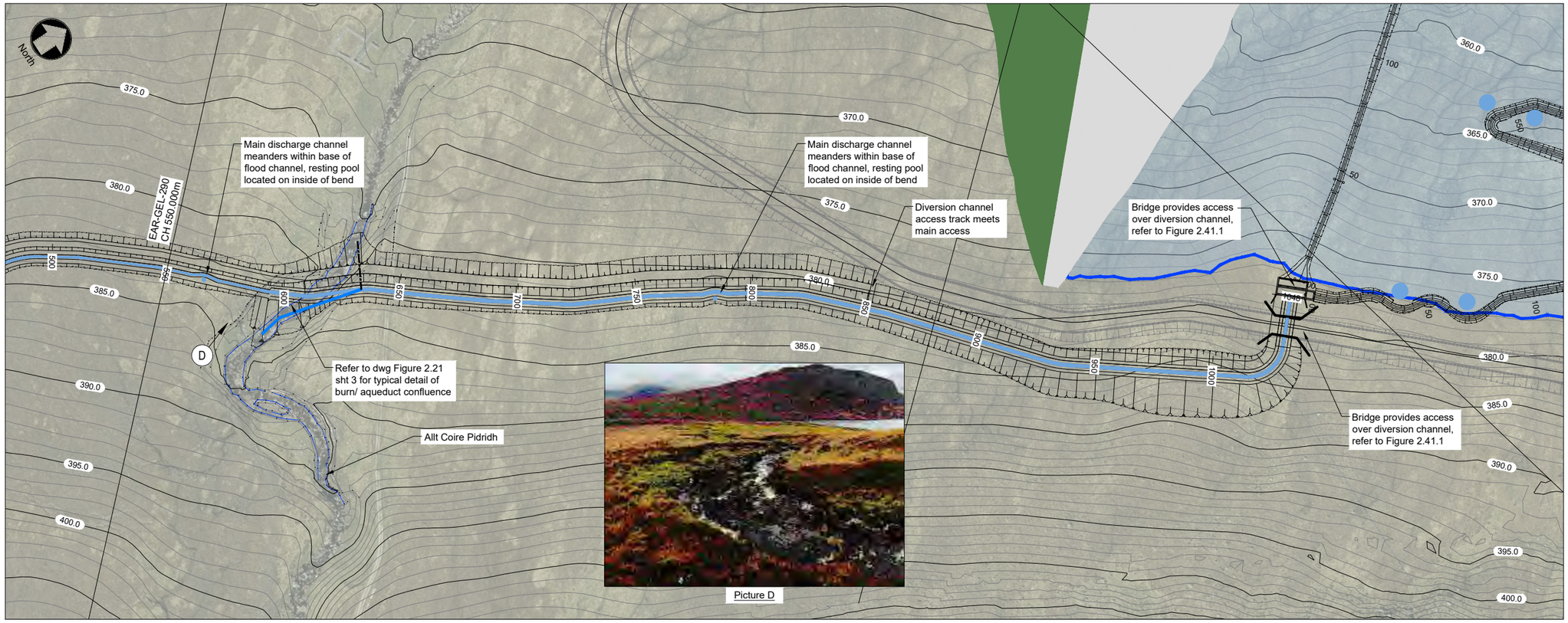
TITLE
PITRIDH CHANNEL DIVERSION
PLAN AND LONG SECTION
FIGURE 2.20 - SHEET 1

SIZE	SCALE AT A3	STATUS
A3	1:2000 @ A3	PLANNING

DRAWING NUMBER: EAR/GEL/290
REVISION: P1



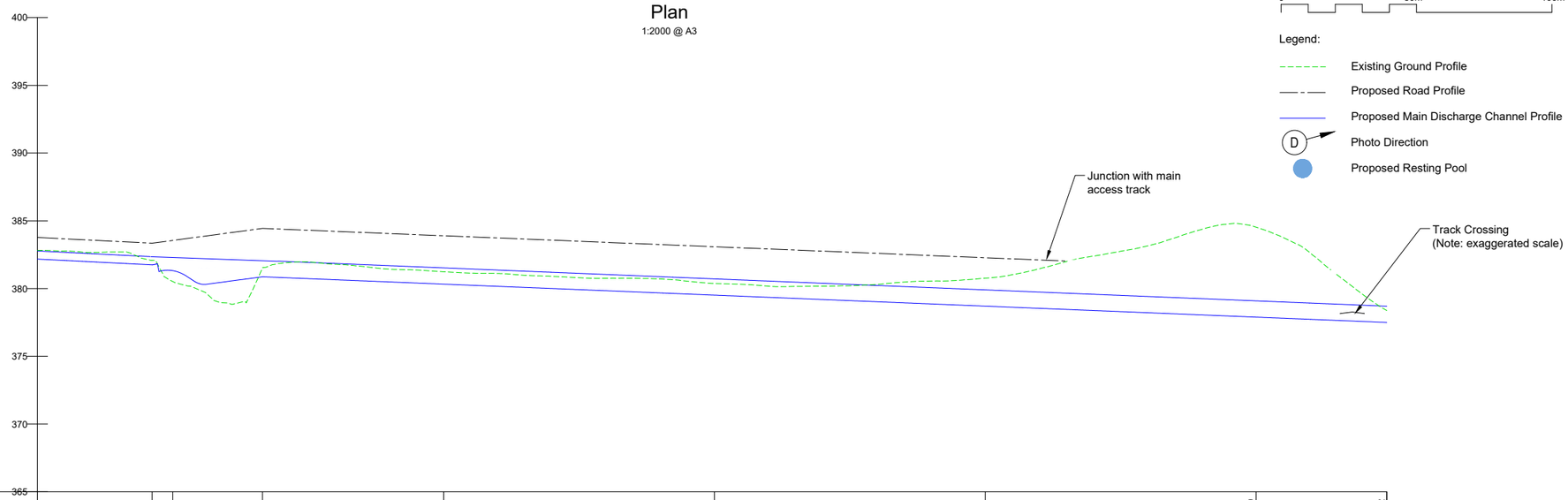
Plan

1:2000 @ A3

0 50m 100m

Legend:

- Existing Ground Profile
- Proposed Road Profile
- Proposed Main Discharge Channel Profile
- Photo Direction
- Proposed Resting Pool



LONGITUDINAL SECTION

(A-DIVERSION CHANNEL)

CHAINAGE: 550 TO 1048
SCALE: H 1:1000, V 1:200

Chainage	550.000	592.375	600.000	633.107	700.000	800.000	900.000	1000.000	1048.262
Existing Levels	382.818	382.081	380.517	381.527	381.240	380.375	380.768	384.531	378.379
Proposed Levels	383.771	383.348	383.552	384.440	383.897	383.085	382.273	381.462	381.070
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 3 1:100				Section 4 1:100				

0 50m 100m

IF IN DOUBT - ASK

NOTES

Aqueduct Notes

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Bridge Notes

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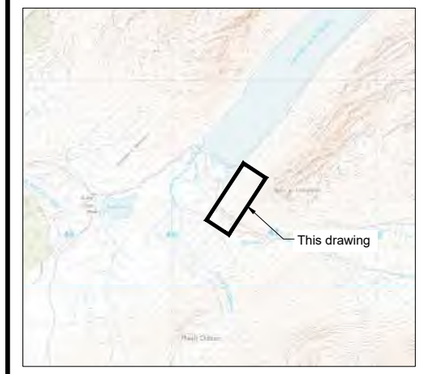

Location Plan

1:30,000 @ A1

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	x	MW	CAR LICENCE SUBMISSION 13/11/24	DT	GRM
P1	02.02.24	MW	FOR PLANNING	DT	GRM

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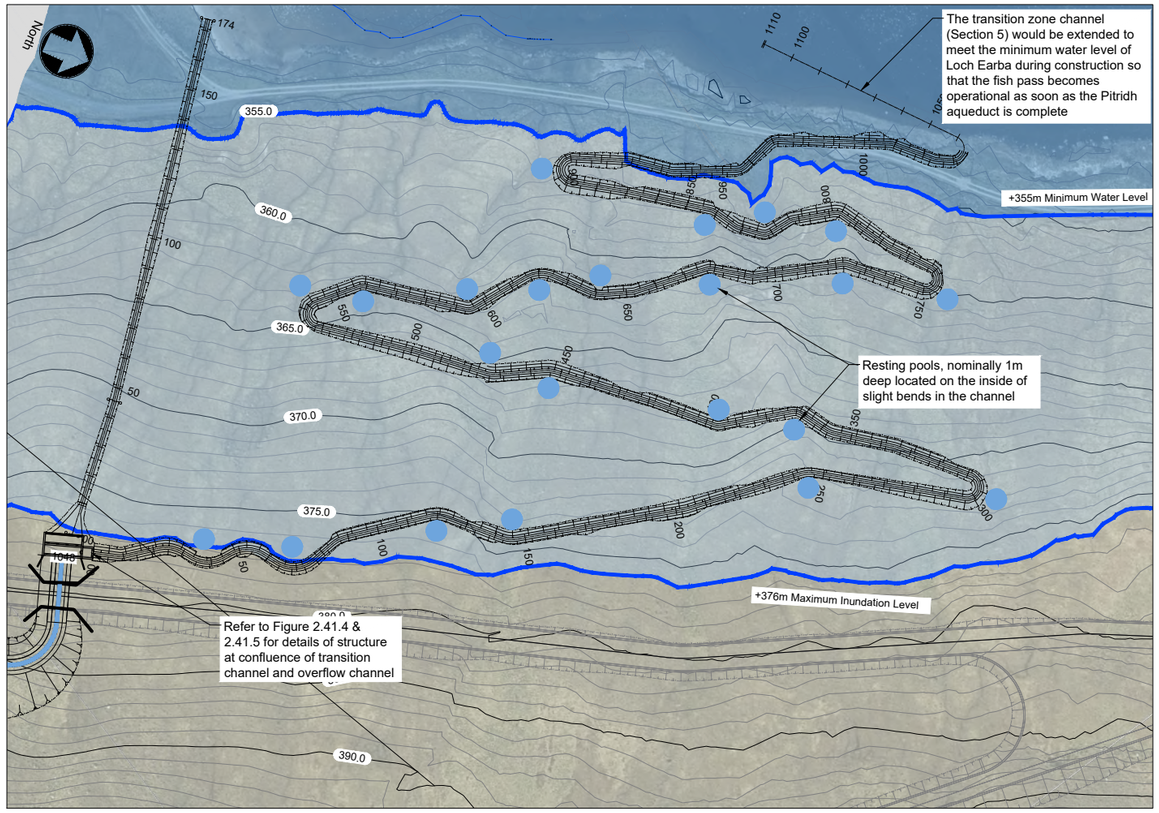
TITLE

PITRIDH CHANNEL DIVERSION
PLAN AND LONG SECTION
FIGURE 2.20 - SHEET 2

SIZE	SCALE AT A3	STATUS
A3	1:2000 @ A3	PLANNING

DRAWING NUMBER	REVISION
EAR/GEL/291	P1



Plan
1:2000 @ A3

0 50m 100m

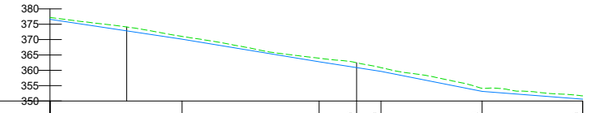
Legend:

- Existing Ground Profile
- Proposed Road Profile
- Proposed Main Discharge Channel Profile
- D — Photo Direction
- Proposed Resting Pool

LONGITUDINAL SECTION

(A-SECTION 6)

CHAINAGE: 0 TO 174
SCALE: H 1:250, V 1:250



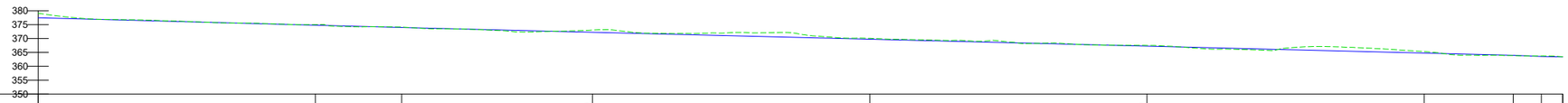
Chainage	0.000	43.063	87.781	100.000	107.989	140.943	173.759
Existing Levels	377.196	371.038	363.933	362.469	360.864	354.153	351.662
Proposed Levels	376.601	370.130	362.781	360.881	359.638	353.131	350.576
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 6 Gradient Varies, typically 10% - 14%						

0 50m 100m

LONGITUDINAL SECTION

(SC3 CHANNEL)

CHAINAGE: 0 TO 550
SCALE: H 1:1000, V 1:1000



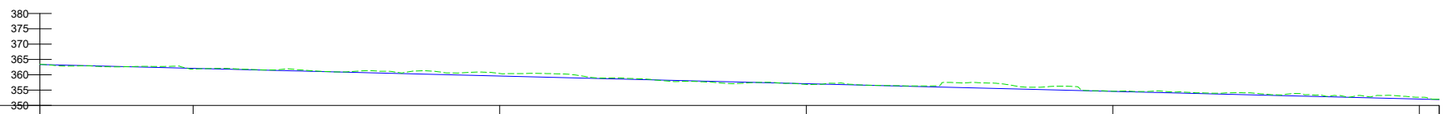
Chainage	0.000	100.000	131.168	200.000	300.000	400.000	500.000	532.130	542.291	550.000
Existing Levels	379.116	375.019	374.142	373.058	370.089	367.531	365.295	363.864	363.759	363.435
Proposed Levels	377.500	374.814	373.977	372.256	369.756	367.256	364.756	363.953	363.546	363.353
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 5 1:40									

0 50m 100m

LONGITUDINAL SECTION

(SC3 CHANNEL)

CHAINAGE: 550 TO 1006
SCALE: H 1:1000, V 1:1000



Chainage	550.000	600.000	700.000	800.000	900.000	1000.000	1006.452
Existing Levels	363.435	361.867	360.429	356.854	354.634	352.684	352.037
Proposed Levels	363.353	362.103	359.603	357.103	354.603	352.103	351.942
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 5 1:40						

0 50m 100m

IF IN DOUBT - ASK

NOTES

Aqueduct Notes

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Bridge Notes

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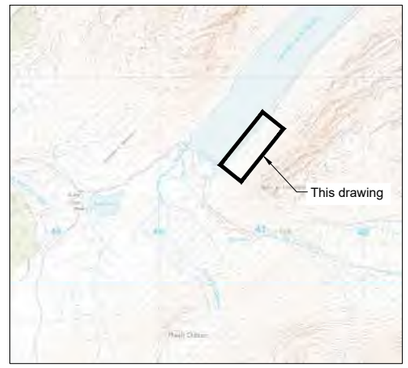

Location Plan
1:30,000 @ A1

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	x	MW	CAR LICENCE SUBMISSION 13/11/24	DT	GRM
P1	02.02.24	MW	FOR PLANNING	DT	GRM

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EARBA PSH

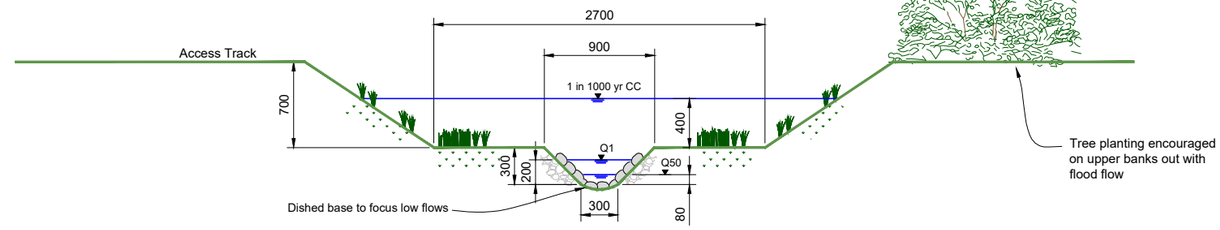
TITLE

PITRIDH CHANNEL DIVERSION
PLAN AND LONG SECTION
FIGURE 2.20 - SHEET 3

SIZE	SCALE AT A3	STATUS
A3	1:2000 @ A3	PLANNING

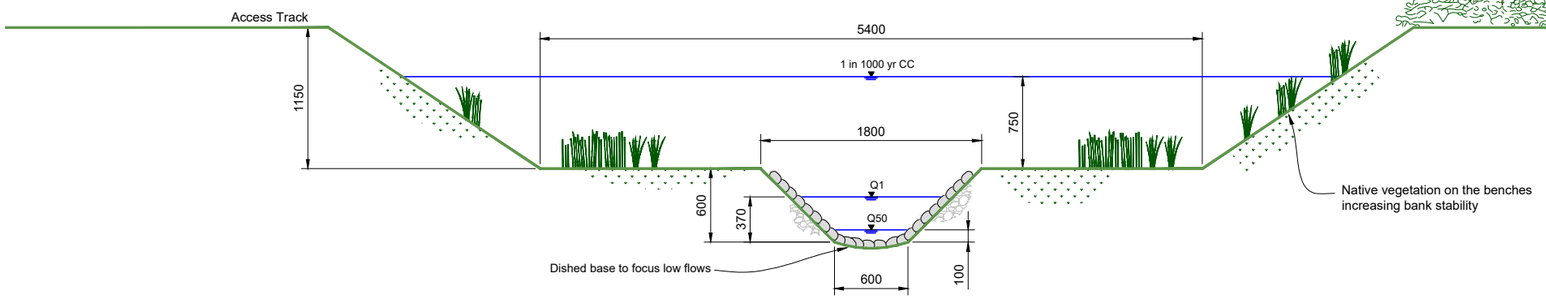
DRAWING NUMBER: EAR/GEL/292

REVISION: P1



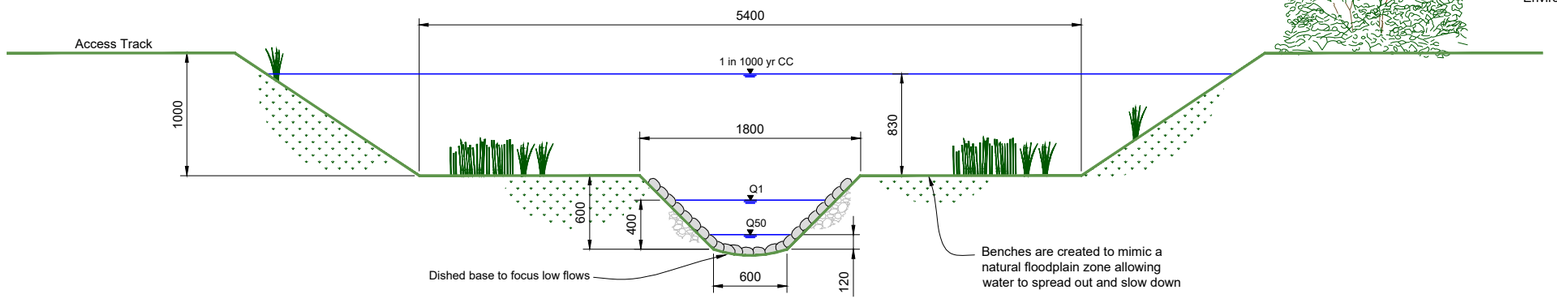
Section1 Channel Dimensions
(Trib 2 to Allt Coire Chalachair)

1:50 @ A3



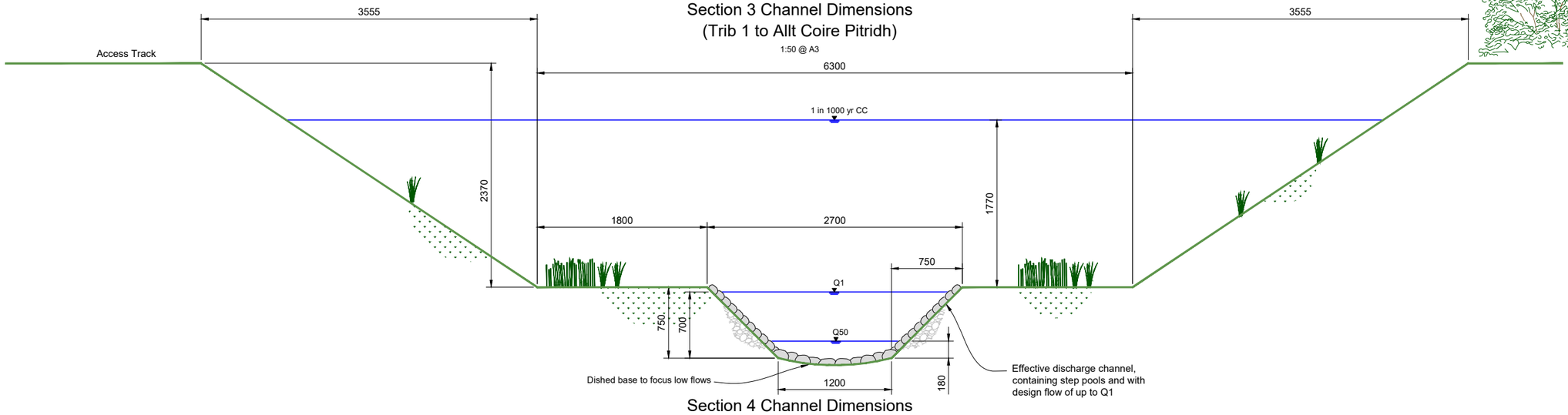
Section 2 Channel Dimensions
(Allt Coire Chalachair to Trib 1)

1:50 @ A3



Section 3 Channel Dimensions
(Trib 1 to Allt Coire Pitridh)

1:50 @ A3



Section 4 Channel Dimensions
(Allt Coire Pitridh to Loch Earba transition zone)

1:50 @ A3

0 1.25m 2.5m

IF IN DOUBT - ASK

NOTES

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Approximate velocities for Pitridh Aqueduct (m/s)

	Q90	Q50	Q1	1 in 10
Section1 (Trib 2 to Allt Coire Chalchair)	0.2200	0.3200	0.5900	0.9700
Section 2 (Allt Coire Chalachair to Trib1)	0.3500	0.4200	0.9100	1.5700
Section 3 (Trib 1 to Allt Coire Pitridh)	0.3800	0.4900	0.9400	1.7200
Section 4 (Allt Coire Pitridh to Loch Earba)	0.4900	0.6900	1.3500	1.9500
Section 5 Earba Transition zone	0.7300	0.9100	2.1600	N/A

* Table above meets the requirements of Table 5 in the Environmental Agency Fish Pass Manual

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	13.11.24	MH	CAR LICENCE SUBMISSION	DT	GMcG
P1	02.02.24	MW	FOR PLANNING	DT	GMcG

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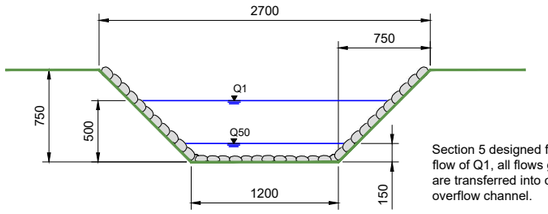
TITLE

PITRIDH AQUEDUCT
DETAILS - SHEET 1
FIGURE 2.21.1

SIZE	SCALE AT A3	STATUS
A3	1:50	PLANNING

DRAWING NUMBER: EAR/GEL/295

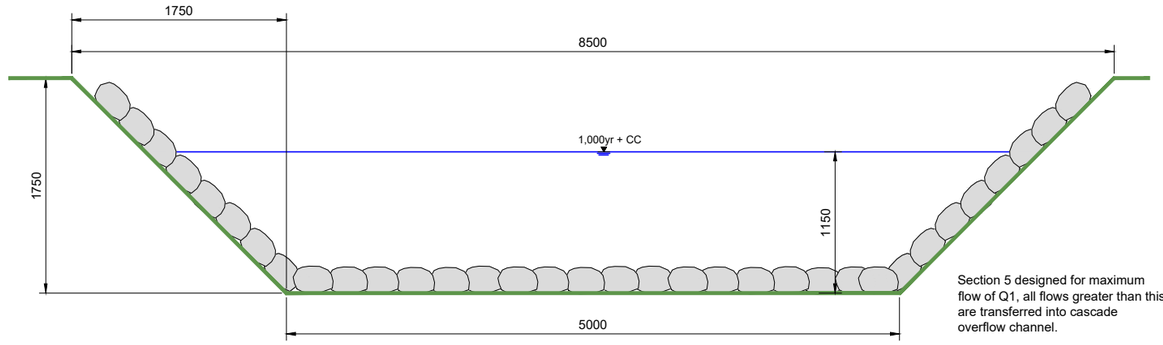
REVISION: P2



Section 5 designed for maximum flow of Q1, all flows greater than this are transferred into cascade overflow channel.

Section 5 Channel Dimensions
(Loch Earba transition zone and Moy Habitat Channel)

1:50 @ A3



Section 5 designed for maximum flow of Q1, all flows greater than this are transferred into cascade overflow channel.

Section 6 Channel Dimensions
(Loch Earba transition zone overflow channel)

1:50 @ A3

IF IN DOUBT - ASK

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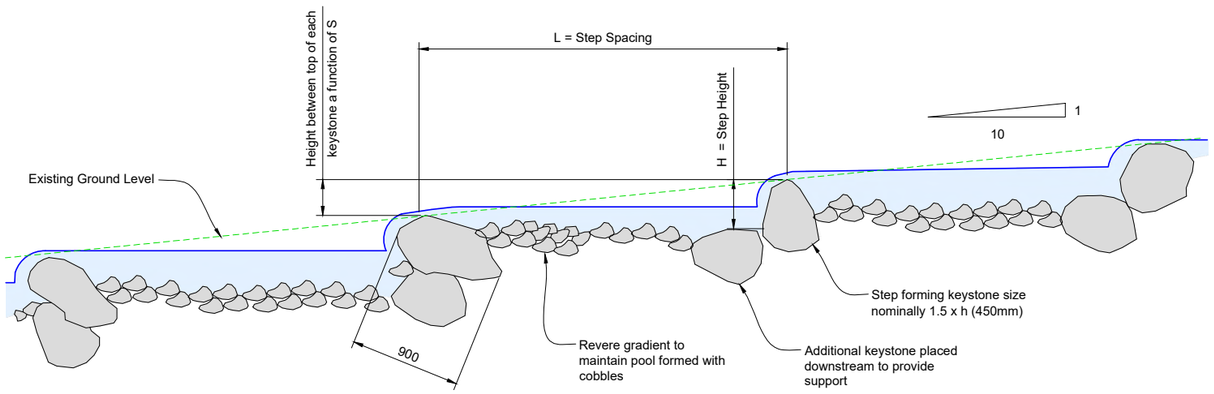
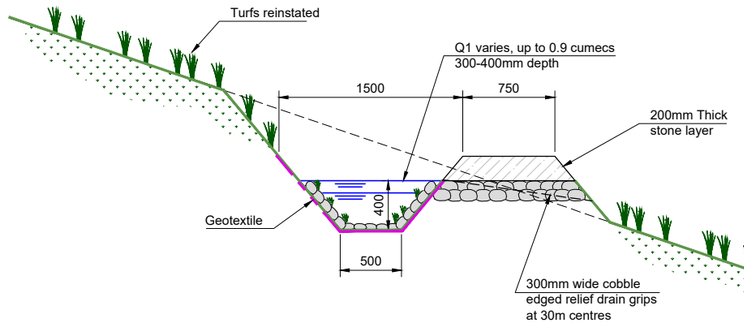
Cascade Parameters for Pitridh Aqueduct overflow and Leamhain catchwater					
	S = Slope	H= Step height (m)	L = Length between steps (m)	Drop between pools (m)	Typical Keystone Size (mm)
Section6 (Pitridh Overflow)	10%	0.400	3	0.3	600
Leamhain catchment transfer ditch	10%	0.2500	2.5	0.250	400.000
Moy Spillway	10%	0.400	3	0.3	600



Typical Cascade Detail
Pitridh Aqueduct Overflow and Leamhain Catchwater Ditch and Moy Spillway Channel

1:50 @ A3



Typical 0.75m Wide Footpath & Catchwater Cut-off Ditch at Leamhain

1:50 @ A3

0 1.25m 2.5m

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	13.11.24	MH	CAR LICENCE SUBMISSION	DT	GMcG
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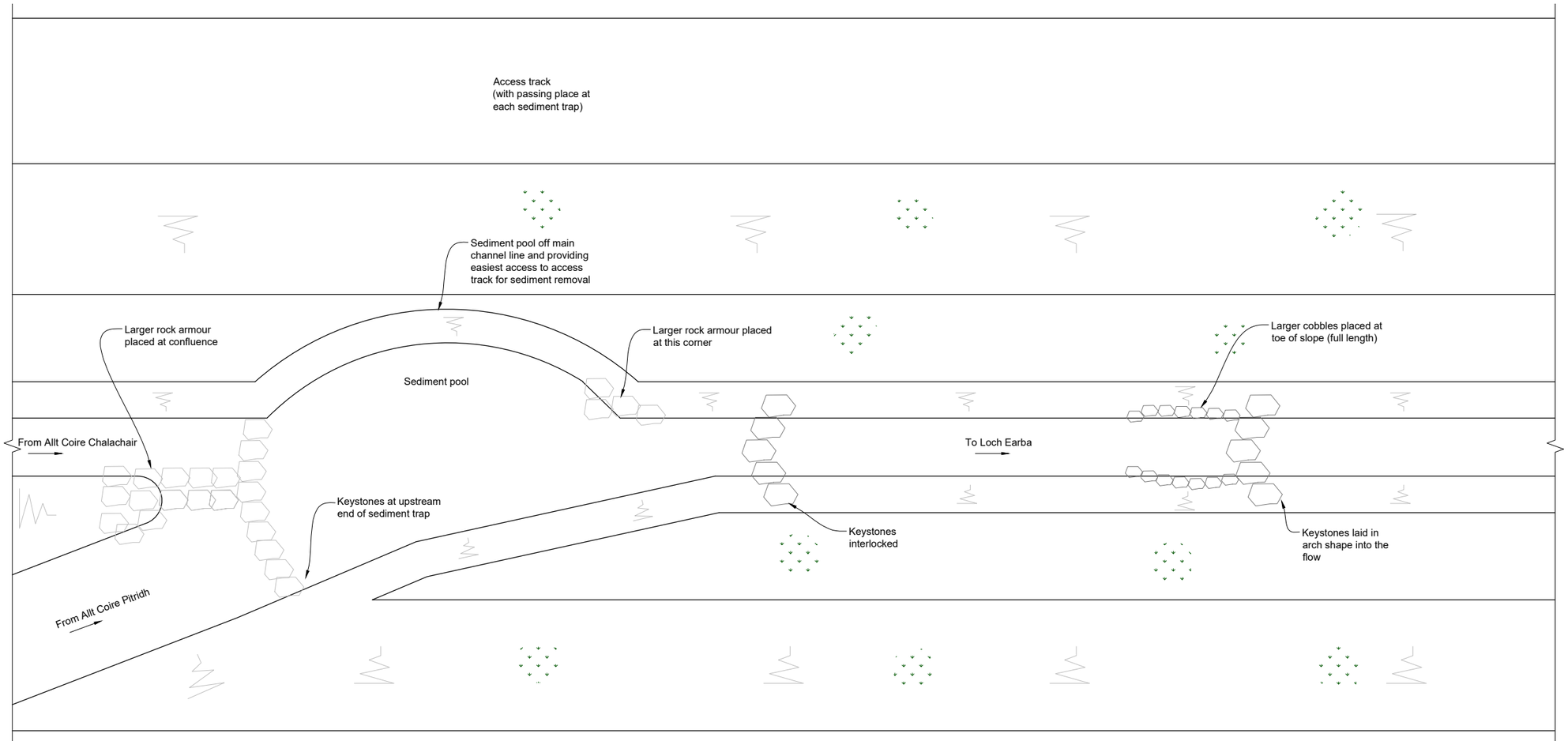
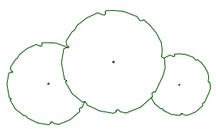
PITRIDH AQUEDUCT
DETAILS - SHEET 2
FIGURE 2.21.2

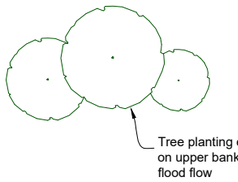
SIZE	SCALE AT A3	STATUS
A3	1:50	PLANNING

DRAWING NUMBER: EAR/GEL/296

REVISION: P2



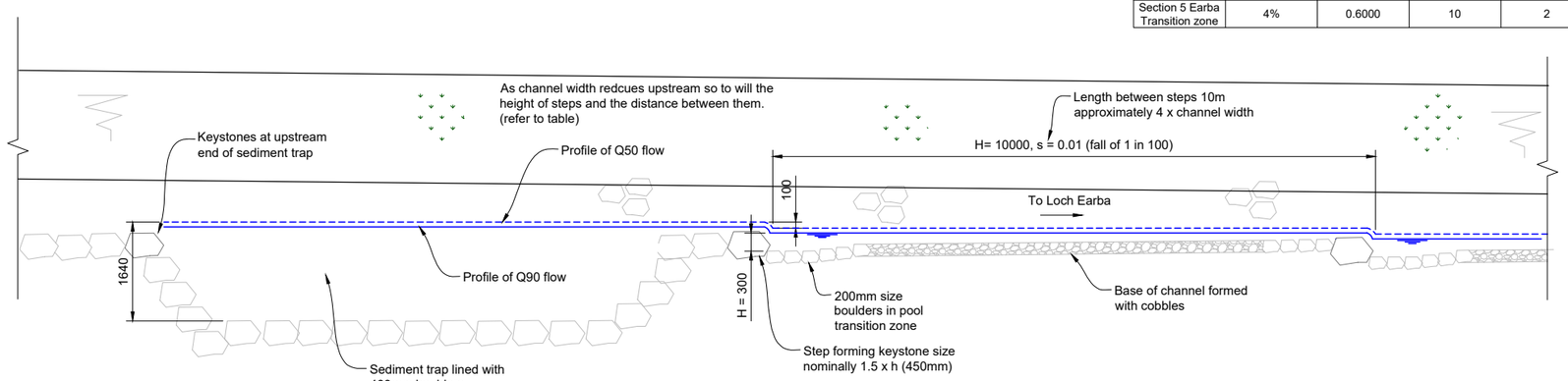




Plan on confluence of Allt Coire Pitridh to Pitridh Aqueduct

1:100 @ A3

Step Pool Parameters for Pitridh Aqueduct					
	S = Slope	H =Step height (m)	L = Length between steps (m)	Step Pool geometry factor	Typical Keystone Size (mm)
Section1 (Trib 2 to Allt Coire Chalchair)	1%	0.2000	5	4	300
Section 2 (Allt Coire Chalachair to Trib1)	1%	0.2500	7	3.5700	375
Section 3 (Trib 1 to Allt Coire Pitridh)	1%	0.2500	7	3.570	375
Section 4 (Allt Coire Pitridh to Loch Earba)	1%	0.3000	10	3	450
Section 5 Earba Transition zone	4%	0.6000	10	2	600



Section on confluence of Allt Coire Pitridh to Pitridh Aqueduct

1:100 @ A3

IF IN DOUBT - ASK

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CLIENT

EARBA STORAGE
A GILKES ENERGY COMPANY

PROJECT

PROPOSED
EARBA PSH

TITLE

PITRIDH AQUEDUCT
DETAILS - SHEET 3
FIGURE 2.21.3

SIZE	SCALE AT A3	STATUS
A3	1:100	PLANNING

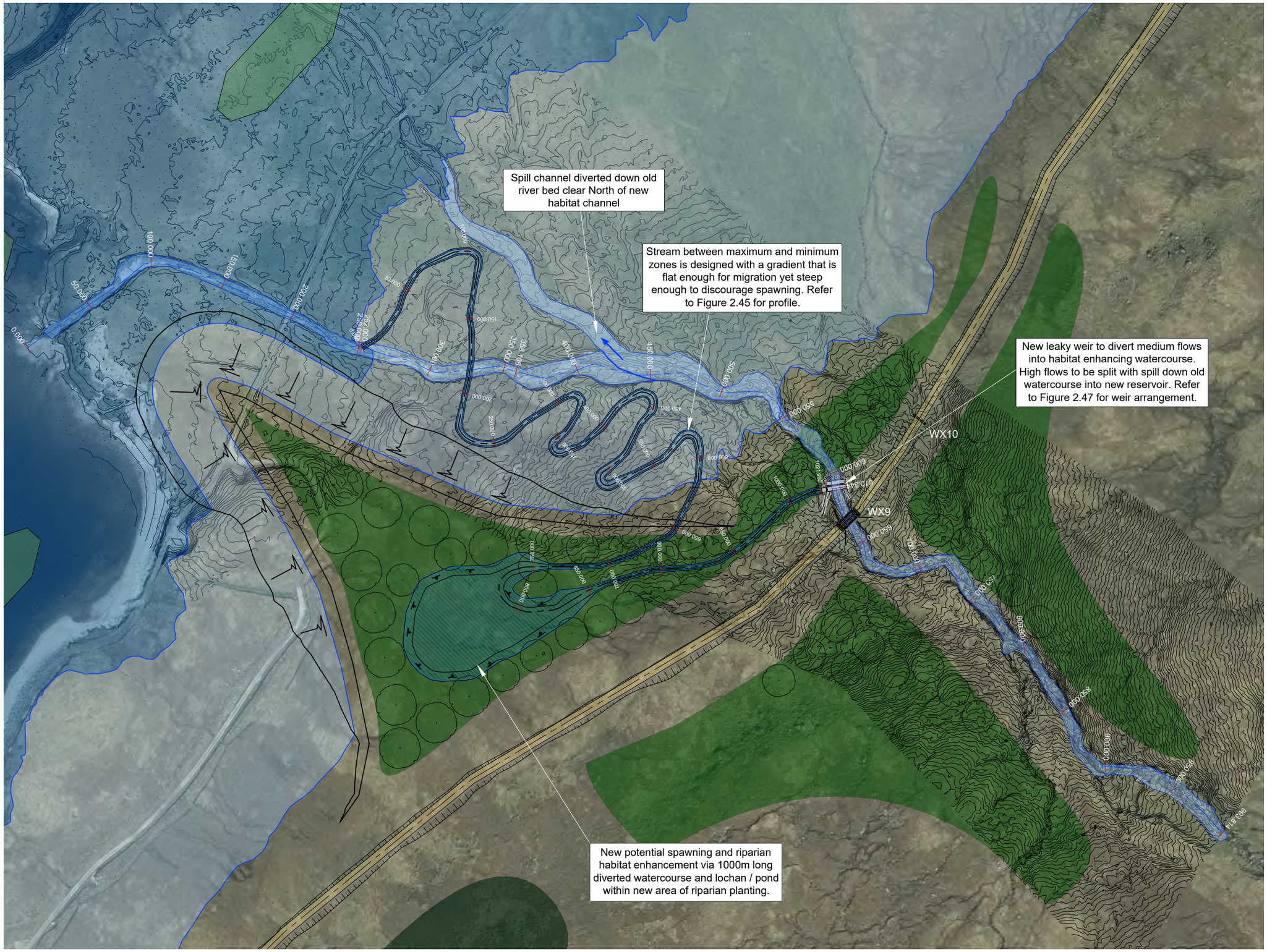
DRAWING NUMBER

EAR/GEL/297

REVISION

P1

North



Plan
Moy Burn Spawning Habitat Enhancement
1:1250 @ A1, 1:2500 @ A3

0 62.5m 125m

IF IN DOUBT - ASK

NOTES

1. All levels are in metres above ordnance datum (mAOD).
2. All chainages are in metres.

LEGEND

- Existing Stream
- New Stream and Lochan
- New Tree Planting - Riparian Mix
- New Tree Planting - Upland Mix
- New Tree
- +376m Maximum Inundation Level
- +355m Minimum Water Level
- Promontory
- PSH Track
- Floating Habitat

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P2	13.11.24	MH	CAR LICENCE SUBMISSION	DT	GMcG
P1	29.08.24	MH	PRELIMINARY	DT	GMcG

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EARBA PSH

TITLE
MOY BURN
HABITAT ENHANCEMENT WORKS
AREA PLAN - FIGURE 2.44.1

SIZE	SCALE AT A3	STATUS
A3	1:2500	PRELIMINARY

DRAWING NUMBER: EAR/GEL/240
REVISION: P2