EARBA STORAGE

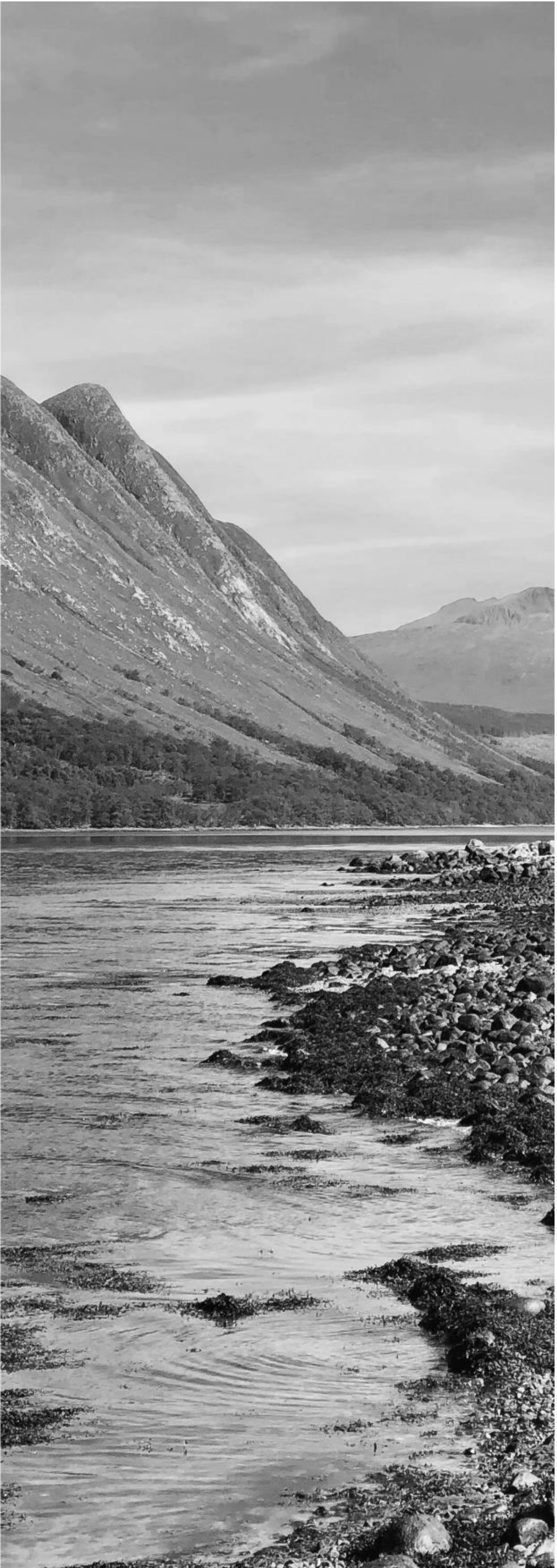
A GILKES ENERGY COMPANY

Earba Pumped Storage Hydro Scheme

CAR Licence Application Report

Appendix J: Aquatic Ecology Technical Appendix for the CAR Licence Report

December 2024



AQUATIC ECOLOGY TECHNICAL APPENDIX FOR THE CAR LICENCE APPLICATION REPORT

EARBA PUMPED STORAGE HYDROSCHEME

EARBA LTD.

19/12/2024

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V1.0	19/12/2024	[redacted]			Initial issue for CAR Licence application

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

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Executive Summary

Gavia Environmental Ltd. was commissioned by Earba Ltd. to undertake a range of aquatic ecology surveys within Lochan Na-hEarba (hereafter referred to as Loch Earba) and Loch a' Bhealaich Leamhain (hereafter referred to as Loch Leamhain) and affected watercourses in relation to the proposed Earba Pumped Storage Hydroscheme (PSH). Surveys undertaken were in relation to fish population and species, macroinvertebrates, water quality, macrophytes and fish habitat quality, and informed by Scoping Responses/Opinions.

This document has been compiled to inform a CAR Licence Application for the Proposed Development.

Macroinvertebrate Survey

Macroinvertebrate surveys were undertaken in 2023 at ten survey locations in accordance with standard Scottish Environment Protection Agency (SEPA) and Environment Agency (EA) kick sampling methodology. Samples were analysed and scored in accordance with the following biotic indices: Biological Monitoring Working Party (BMWP), Proportion of Sediment-sensitive Invertebrates (PSI), Community Conservation Index (CCI), and Empirical Proportion of Sediment-sensitive Invertebrates (EPSI).

Macroinvertebrate results indicated variation in water quality. Within Loch Earba East and adjoining tributaries Survey Locations MS1 and MS2 indicated high water quality with high Biological Monitoring Working Party (BMWP) (118 and 82), PSI (77.27 and 95.00) and EPSI (89.78 and 100.00). MS02 displayed high BMWP, PSI and EPSI scores, however, the CCI score was considerably lower. Summer sampling was also indicative of variation scoring highly on BMWP (73 and 125) and EPSI (89.87 and 94.79) indices.

Within Loch Earba West and adjoining tributaries Survey Location MS03 scored high BMWP (75), PSI (100), EPSI (100) but low on CCI (6.00). Similarly, MS04 scored low BMWP (22) but high PSI (100), EPSI (83.33) and very high CCI (17.5), the highest CCI observed. Little variation was observed between Spring and Summer sampling.

Within Loch Leamhain MS7 scored moderately on BMWP, PSI and EPSI but indicated Fairly high conservation value on the CCI index throughout both Spring and Summer sampling. MS8 indicated very high BMWP (122), PSI (95.24), EPSI (95.42) and CCI (14.00).

Several species of conservation value were identified including the Arctic-alpine pea mussel (*Euglesa conventus),* Davis's river diver (*Oreodytes davisii*) and of oligotrophic lentic specialists (*Oligotrophic striata* and *Apatania wallengreni*).

Water Quality

Water quality was undertaken in 2023 at 10 water quality monitoring locations in tandem with macroinvertebrate survey locations. Water quality was measured *in-situ* for: pH; Temperature; Electrical Conductivity; Total Dissolved Solids; Dissolved Oxygen; and Oxidative Reduction Potential.

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).

All temperature values were within 6 - 20°C established optimal ranges, however, no Survey Locations reached optimal growth values of 16 -17°C.

pH ranges fell outwith optimal ranges for salmonids (pH 6.5 – 8.0) at six Survey Locations, however, these deviated by pH 0.4 below pH 6.5. All other Survey Locations fell within optimal ranges, no Survey Locations observed values too alkaline.

Electrical Conductivity ranged from 20 – 52 µS/cm, all values were considered low and did not indicate pollution sources present.

Total Dissolved Solids ranged from 13 – 35 mg/l, all values were considered low and did not indicate pollution sources present.

Dissolved Oxygen ranged from 89.6 – 110% saturation and 9.8 - 12.5 mg/l. All values fell within criteria assessment of 8-15 mg/l with no Survey Locations being considered hypoxic or hyperoxic.

Oxidative Reduction Potential ranged from 109.6 – 163.7 mV.

Fish Habitat

Fish habitat surveys were undertaken in 2023 on all major watercourses likely to be affected by the Proposed Development using an adapted SEPA fish habitat methodology. Areas of suitable spawning for salmonids and obstructions to fish passage/migration were additionally noted.

Fish Habitat results indicated a dominance of Productive habitat type, covering 91.46% of habitat surveyed; this was sub-categorised into Productive (high) at 2.47%; Productive (moderate) at 69.95%; and Productive (low) at 19.69%. Lamprey and Not Suitable habitat types were present at 0.23 and 7.95% respectively. No Bedrock habitat types were present. Losses in habitat due to the proposed inundation levels were dominated by Productive (moderate), Productive (low) and Not Suitable; all Productive (high) habitat would be lost.

Loch Spawning Habitat Assessment

An Arctic charr spawning habitat assessment undertaken in 2024 indicated a small minority of the Loch Earba habitat was physically optimal (c. 21%) within 15m transects perpendicular to the water's edge. Deep water sampling locations featured almost exclusively poor spawning habitat (97.5%). An assessment of the potential impact of the current hydro scheme's operational impact on the water level and spawning habitat viability has been undertaken. This assessment indicates that the effect of potential water level reductions reduces the hydrologically viable spawning habitat classifications under the lowest allowable water level to optimal (6.4%), sub-optimal (1.8%) and poor (35.6%) respectively. 56% of the surveyed habitat is situated above the minimum water level.

Fish Population Assessment

Gill netting surveys were undertaken in 2023 on both basins of Loch Earba in accordance with the methodology outlined in Bean (2003). 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 Loch Earba East. Arctic charr were initially presumed to be present in both basins due to the presence of suspected juvenile Arctic charr in adjoining tributaries of Earba West, in 2023 survey results. Both Arctic charr populations were determined to be in unfavourable condition at this time. Following feedback from SEPA, 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 eDNA results, which indicated the absence of Arctic charr in both Loch Earba West and Loch Leamhain, further questioned the scientific merit and ethical implications of undertaking this survey work given its widely recognised dis-benefits, including extensive fish mortality.

Electrofishing

Electrofishing undertaken during 2023 identified three species; Brown trout, Eurasian minnow and Arctic charr. Minnow were not found in the Loch Leamhain catchment. Some uncertainty exists over the identification of Arctic charr from the 2023 surveys due to the difficulties of speciating very small fish specimens (<50mm length). The results of the fully quantitative surveys indicated low population densities ranging from 0.03 fish per m^2 (EA3) to 0.81 fish per m^2 (EA5). The results of the semi-quantitative surveys indicated higher population densities ranging from 1.5 -4.8 fish per m^2. Three survey locations (EA7 – EA9) indicated no presence of fish.

Electrofishing undertaken during 2024 in the Loch Earba feeder watercourses only identified two species; Brown trout and Eurasian minnow. Fully quantitative population estimates for brown trout fry (0+) ranged from 6.1 per $100m^2$ (EA3) to 58 per $100m^2$ (EA5). For brown trout parr (1++), most densities captured were low therefore some of the results could not be applied to the statistical depletion model (EA1, EA3 & EA5). These densities are expressed as a minimum estimate. Fully quantitative density estimates for brown trout parr ranged from 4.2 per 100 m^2 (EA2) – 8.3 per 100 m^2 (EA6). Including minimum density estimates, densities ranged from absent (EA1) to 8.3 per 100 m^2 (EA6).

No Arctic charr were detected in the 2024 electrofishing surveys. There are at least three possible explanations for this:

- The 2023 charr identifications were mistaken. There is a recognised difficulty in accurately speciating fish fry specimen in individuals which are <50 mm in length. While every professional effort has been made to accurately speciate all individual fish captured (including the use of expert external verification), there remains a possibility that individual fish specimens may have been mis-identified (either during the 2023 or 2024 survey results).
- It is possible that in 2023 Arctic charr thought to have been detected were juveniles using burns as nursery areas (Maitland *et al.*, 1984) and this recruitment did not take place during the following spawning season.
- The absence of Arctic charr in 2024 may be that the juveniles had already migrated downstream to Loch Earba before the time that the electrofishing survey had taken place. This may also explain why there were no 1++ juvenile charr / adult charr present at the survey locations. This represents a limitation to the population survey and is a trade off against juvenile fry being of suitable size to identify to species level. It was previously agreed with SEPA that the population survey should take place later on in the survey season (mid to late August) to allow for easier identification of fry to species level.

eDNA analysis

The results of an eDNA sampling exercise undertaken during 2023 indicated the absence of Arctic charr from Loch Leamhain, albeit there was some uncertainty surrounding the result due to sample size and methodological limitations.

A more comprehensive eDNA sampling exercise undertaken during 2024 indicated the presence of Brown trout in all three lochs. The presence of Eurasian minnow was indicated in both basins of Loch Earba. The presence of Arctic charr was only indicated in Loch Earba East. The proportion of Arctic charr DNA detected in Loch Earba East represented a trace proportion (<0.5%) of the total fish DNA detected.

Macrophyte Survey

Macrophyte surveys were undertaken in accordance with the standard approach to biological monitoring of standing water habitats, as is recommended by the Joint Nature Conservation Committee. Four 100 m transects were conducted per waterbody (considered representative where the waterbody area is <100 ha). Locations of the transects were strategic to characterise macrophyte communities and/or where species of interest are likely to occur. As historical macrophyte data was not present prior to this survey, transect locations were chosen to represent the potential range of habitats or species within the marginal areas of waterbodies. This was assessed by undertaking an initial walkover of the waterbody perimeter prior to conducting transect surveys. A strandline survey and a wader survey were carried out in each waterbody examined.

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.

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

1 Introduction

Gavia Environmental Ltd. was commissioned by Earba Ltd. (hereafter 'The Client') to undertake aquatic surveys within Lochan Na-Hearba (hereafter referred to as Loch Earba) and Loch a' Bhealaich Leamhain (hereafter referred to as Loch Leamhain) and affected watercourses in relation to the proposed Earba Pumped Storage Hydroscheme (PSH). Although Loch Earba is considered to be one waterbody, it is considered to have two basins (separated by a river and dam) hereafter referred to as Loch Earba East (approximate grid reference NN 49477 84783) and Loch Earba West (approximate grid reference NN 47315 82322).

Surveys undertaken were in relation to fish population and species, macroinvertebrates, water quality, macrophytes and fish habitat quality.

This document has been compiled to inform a CAR Licence Application for the Proposed Development.

1.1 Background

The client is proposing to construct a new long-scale long duration 1500 MW pumped storage hydroscheme and associated infrastructure on Loch Earba and 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 peripheral habitat will be inundated (submerged in water) as shown in **Appendix A, 'Proposed Development'**. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

1.2 Scoping and Consultation

To inform the scope of the assessment for the Proposed Development, consultation was undertaken with both statutory and non-statutory bodies. Full details of the consultation responses and scoping opinion specific to Aquatic Ecology can be reviewed in the CAR Licence Application report.

NatureScot was consulted on the presence of Freshwater Pearl Mussels, *Margaritifera margaritifera,* within the catchment. NatureScot responded 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*'[1], therefore surveys were not undertaken.

SEPA was consulted on the proposed aquatic surveys and the methodologies employed.

MarineScotland was consulted on the gillnetting methodology employed, as stated on the licences, and prior to any changes in methods employed.

Baseline surveys undertaken were guided by scoping responses/opinion and included:

- Macroinvertebrate sampling;
- Water quality;
- Fish habitat and spawning habitat;
- Fish population surveys (electrofishing, gillnetting and eDNA); and
- Macrophytes.

[1] C. Mertens (NatureScot), personal communication, 02/06/2023

1.3 Licencing

Gillnetting was conducted in 2023 under a Marine Scotland issued licence (Application Reference CSM-23-118 to 119). All licence conditions were met.

Marine Scotland issued a further licence for gillnetting in 2024 (Application Reference CSM-24-204), however these licenced works were ultimately not carried out.

Electrofishing during 2023 was conducted under a Marine Scotland issued Licence (Application Reference CSM-23-117).

Electrofishing during 2024 was conducted under a Marine Scotland issued Licence (Application Reference CSM-24-034).

1.4 Survey dates

Dates surveys were conducted on are provided in **Table 1**.

Table 1. Survey Dates

Field Survey	Survey Dates	Surveyors
Macroinvertebrate sampling	Spring Sampling: May 2023 Autumn Sampling: September 2023	[redacted]
Water quality	May and September 2023	[redacted]
Fish habitat assessment	May 2023	[redacted]
Spawning habitat assessment	September 2024	[redacted]
Fish population assessment (electrofishing)	July 2023	[redacted]
	August 2024	[redacted]
Fish population assessment (Gillnetting)	August/September 2023	[redacted]
eDNA	October 2023	[redacted]
	October 2024	[redacted]

Field Survey	Survey Dates	Surveyors
Macrophyte survey	September 2023	[redacted]

2 Methodology

2.1 Desk Study

A desktop study was carried out at the start of the commission and ahead of the initial field surveys. Information sources used for this study are described below:

- Bing Maps – aerial imagery was obtained and used to inform the field surveys;
- Ordnance Survey Map – site mapping was reviewed to inform survey location selection;
- Scotland's Environment Web – data on obstacles to fish migration on affected watercourses obtained to guide likely species present;
- SEPA – the SEPA Water Classification Hub was referred to for information on the classification status of the affected watercourses;
- NatureScot Sitelink – A search was performed to identify sites with relevant (aquatic) interests within 2 km of the development; and
- National Library of Scotland – bathymetric data on waterbodies.

2.2 Field Surveys

2.2.1 Macroinvertebrate

The survey locations, shown in **Table 2**, were used for repeat monitoring; available in (**Appendix A, Figure 1-2**).

Survey locations were chosen to be representative of the features of the river system. Given that the river system is typical of upland streams (i.e., fast-flowing, steep margins) riffles are generally considered the most suitable morphological feature for sampling the aquatic invertebrate assemblage within a given river system.

Table 2. Survey Locations for Macroinvertebrate Sampling and Water Quality Analysis

Survey Locations	British Grid Reference	
	Easting	Northing
MS01	250230	785886
MS02	249534	784553
MS03	248488	78344
MS04	248345	783374
MS05	248475	783741
MS06	248856	784039
MS07	250464	779402
MS08	250584	779355
MS09	246225	781012
MS10	249404	779923

Surveys were collected using the standard Scottish Environment Protection Agency / Environment Agency kick sample method. A three-minute kick sample was conducted in riffled areas, moving within the river to account for differences in substrate and habitat types. During each kick sample the net was held down-stream of the surveyor, with its bottom edge in contact with the substrate. The surveyor kicked and dislodged the substrate, moving slowly backwards, and in an upstream direction. Invertebrates dislodged from the substrate were washed downstream and trapped in the pond net. This was followed by a one-minute manual search in which substrate too large to dislodge during the initial three-minute sample were over-turned and examined. To account for surface macroinvertebrate presence a further one-minute sweep was conducted in the shallow margins and across the surface of the river.

The macroinvertebrate sample was collected using a standard Freshwater Biological Association pond net (mesh diameter 1.0 x 1.0mm); which was disinfected with Virkon S prior to and after use.

Invertebrates and substrate trapped in the pond net or collected during the manual search were stored in a labelled sample bucket (with a paper sample identification label also added to the sample container for security) for later extraction. The sample was fixed with bioethanol prior to analysis.

Macroinvertebrate identification and indices compilation was conducted by GELs accredited sub-contractor.

Macroinvertebrate analysis was conducted on several biotic score indexes. The classification ranges of each biotic score index used is shown in **Table 3**.

Biological Monitoring Working Party (BMWP) measures the biological quality of rivers using invertebrates as indicators on five scores from: Very good; Good; Moderate; Poor and Very poor. The score related to the pollution tolerance of an invertebrate assemblage, and thus the biological quality of the river. Pollution sensitive families score higher than pollution tolerant families. The cumulative score of assigned values of species provides an indication of biological water quality.

Proportion of Sediment-sensitive Invertebrates (PSI) index measures the sedimentation impacts on watercourses based on the conditions fauna are adapted to. This is based on five categories: Heavily sedimented; Sedimented; Moderately sedimented; Slightly sedimented; and Minimally sedimented.

The Community Conservation Index (CCI) is an expression of conservation values and accounts for community richness and the relative rarity of macroinvertebrate species. Each species is assigned a conservation score of 1 – 10 based on a number of parameters ranging from 1 (Very common) to 10 (Red data book 1, Endangered). The sum of the conservation score is calculated and divided by the number of individuals contributing to mean CCI score. Scoring ranges from Low conservation value (conservation score of 0-5) to High conservation value (conservation score of >20).

Empirical Proportion of Sediment-sensitive Invertebrates (EPSI) index measures the sedimentation from fine sediments based on a scale from Dominated by fine sediment (0 score) to Minimal amounts of fine sediments (100 score).

Average Score Per Taxon (ASPT) is derived from the WHPT index and is calculated by dividing the total WHPT score by the Number of Scoring Taxa Present (NTAXA).

Lotic-invertebrate Index for Flow Evaluation (LIFE) assesses the flow conditions using macroinvertebrates, each assigned a LIFE score. The score for each taxa is added together and the total is divided by the number of scoring taxa/species

Table 3. Biotic Score Index Interpretation

BMWP Score Category Interpretation		PSI Score Category Interpretation	
0-10	Very poor	0-20	Heavily sedimented
11-40	Poor	21-40	Sedimented
41-70	Moderate	41-60	Moderately sedimented
71-100	Good	61-80	Slightly sedimented
>100	Very good	81-100	Minimally sedimented
CCI Score Category Interpretation		**EPSI Index Interpretation**	
0-5	Low conservation value	0	Dominated by fine sediment
>5-10	Moderate conservation value		
>10-15	Fairly high conservation value	100	Minimal amounts of fine sediments
>15-20	High conservation value		
>20	Very high conservation value		

2.2.2 Water Quality

In-situ water quality monitoring was taken in relevant watercourses and waterbodies. Initial sampling was undertaken in 12 Survey Locations (including macroinvertebrate survey locations). Repeat water quality was taken at macroinvertebrate survey locations and additional locations within Loch Leamhain. Water quality locations are shown in **Table 4**, and in **Appendix A**, **Figure 1-2**.

Table 4. Water Quality Survey Locations

Survey Location	Description	British Grid Reference	
		Easting	Northing
WQ01	Allt Labhrach	250230	785886
WQ02	Allt Loch Coire Chur	249534	784553
WQ03	Unnamed watercourse Loch Earba East	249631	784596
WQ04	Moy Burn	248488	783444
WQ05	River between Loch Earba East/West	248475	783741
WQ06	Loch Earba East	248856	784039
WQ07	Loch Earba West	246248	781349
WQ08	Allt Coire Pitridh	246225	781012
WQ09	Allt Coire a' Chlachair	246357	780154
WQ10	Tributary of Allt Coire a' Chlachair	246334	780060
WQ11	Loch Leamhain outflow	250584	779355
WQ12	Bridge at Loch Laggan outflow	243249	783003
WQ13	Loch Leamhain inflow	249404	779923
WQ14	Loch Leamhain	250464	779402

Data was obtained using an Aquaread meter (Model: AP-2000) to test for the following parameters:

- Temperature (°C);
- pH;
- Electrical conductivity (Micro Seiemens/cm (µS/cm));
- Dissolved oxygen (mg/L) and (%);
- Total dissolved solids (TDS) (mg/L);
- Turbidity (Nephelometric turbidity units (NTU)); and
- Oxidative reduction potential (mV).

The Aquaread metre was calibrated daily and prior to each sampling session as per the manufacturer's guidance using the RapidCal function.

2.2.3 Fish Habitat

The methodology employed for the fish habitat survey followed adapted guidance from the 'SEPA fish and fish habitat guidance[2] as per the Scoping Opinion.

The full length of watercourse was walked categorising segments into one of four SEPA categories: bedrock channels; lamprey habitat; productive habitat; and an obstruction to migration, as described in **Table 5**.

Productive habitat was sub-categorised into productive (high); productive (moderate); and productive (low) to provide additional information regarding habitat quality and to place on emphasis on the highest quality habitat areas.

Productive (high) was categorised by a dominance of optimal riverine features including the presence of spawning substrate, favourable flow types, depths, substrates and instream cover. Productive (moderate) was categorised by a mix of optimal and sub-optimal features including the presence of some barriers, variation in suitability of flow types, depths, substrates and limited instream cover. Productive (low) was categorised by a dominance of sub-optimal and/or not-suitable riverine features including presence of multiple barriers, limited areas of favourable flow types, depths, substrates and no instream cover.

An additional fifth category of 'Not Suitable' was included to quantify areas where the riverine habitat is not suitable for fish and does not fall into the categories of bedrock or lamprey habitat (e.g. the watercourse was dry at the time of survey).

Lamprey habitat was assessed on juvenile nursery habitat quality, as per SEPA guidance, including areas of stable / fairly stable fine sediments. Habitat for lamprey spawning requirements was not assessed.

Table 5. SEPA Habitat Type Classifications

Habitat Type	Classification	Sub-category
Bedrock Channels	Areas where the streambed is predominantly bedrock, i.e., a continuous rock surface	N/A
Lamprey Habitat	Stable/fairly stable fine sediment, particularly along the edges of watercourses. May be patchy and interspersed among coarser substrates	N/A
Productive Habitat	All other areas, i.e. riffles, pools and glides with mixed bed substrates	Due to wide variance in productive habitat types the sub-categories of productive (high); productive (moderate); and productive (low) have been employed to put an emphasis on the potential loss of high quality habitat.
Obstacles to migration	Potentially impassable waterfalls, weirs, bridge sills, etc	N/A
Not Suitable	Areas of habitat not suitable for aquatic species that do not fit any category listed above.	N/A

Suitability of water quality parameters is assessed under Section 2.2.2 Water Quality.

[2] SEPA. (2023). Information on fish and fish habitat. [Online] Available at: https://www.sepa.org.uk/regulations/water/hydropower/fish-and-fish-habitat/

Obstacles to fish passage and migration were recorded within the survey. Due to the presence of known impassable dams (with no fish pass) downstream it is considered that migratory fish are not present within the survey area, therefore leaping abilities of Atlantic salmon and sea trout, and the climbing abilities of European eel and lamprey sp. were not considered. Features were considered obstacles where watercourse, or anthropogenic, features were likely to prevent movement of fish within a watercourse, such as through a large waterfall or poorly designed culvert.

2.2.4 Loch Spawning Habitat Assessment

A spawning habitat assessment, with specific regard to Arctic charr, was undertaken during September 2024 in Loch Earba. Following completion of a desk study assessment, a boat suspended Spyball camera survey was undertaken. Ten equidistant transects were surveyed across both basins of Loch Earba, with detailed imagery collected at 50m intervals along each transect. Additionally, the first and last 15m of each transect was recorded in full as these areas were considered most likely to contain suitable spawning habitat. Within each 15m section or spot check the substrate composition was noted as % of each substrate size present. Other factors such as the presence of macrophytes were noted.

Data Analysis

Analysis of the collected habitat data was conducted on review of the video footage captured. An adapted Coyle and Adams, 2011 methodology was followed. The Coyle and Adams 2011 methodology was developed for assessing Vendace (Coregonus albula) spawning habitat.

For 'optimal' vendace habitat, any two or more inorganic stony substrates must be present, with less than 10% organic silt present, ranging in size from gravel to boulder and comprising at least 30 % of the area. However, literature sources specific to Arctic Charr cite the availability of clean gravels as key to spawning (Johnson, 1980, Natural England, 2019). On this basis where 'optimal' habitat was recorded based on the Coyle and Adams methodology, this was downgraded to 'sub-optimal' or 'poor' habitat if there was a lack of gravel present.

A secondary analysis using GIS has been undertaken by comparing the surveyed spawning habitat assessment transects against the lowest allowable water level of the existing Ardverikie hydroscheme to attempt the quantify the potential impact of the existing operational regime upon the marginal spawning habitat available. This analysis indicates that approximately 56% of the surveyed spawning habitat lies above the lowest allowable water level under the current operational regime.

For full details of the Loch Spawning Habitat Assessment, please refer to **Appendix E**.

2.2.5 Fish Population (Electrofishing)

During July 2023, electrofishing was conducted at 9 locations where fish habitat was assessed to be of suitable quality to support salmonids during the initial habitat walkover surveys. All surveys were conducted within the Red Line Boundary where relevant landownership was attained. Survey locations are provided in **Table 6**.

Table 6. 2023 Electrofishing Survey Locations

Survey Location	Easting	Northing	Survey Type
EF1	248466	783751	Semi-quantitative
EF2	248475	783444	Semi-quantitative
EF3	246237	781277	Fully-quantitative
EF4	250932	779180	Fully-quantitative
EF5	249556	784520	Fully-quantitative

Survey Location	Easting	Northing	Survey Type
EF6	246405	780832	Fully-quantitative
EF7	249024	783952	Semi-quantitative
EF8	247308	781982	Semi-quantitative
EF9	250154	785750	Semi-quantitative

During August 2024, further electrofishing was conducted at 6 locations where fish habitat was assessed to be of suitable quality to support salmonids during the initial habitat walkover surveys. All surveys were conducted within the Red Line Boundary where relevant landownership was attained. Survey locations are provided in **Table 7**.

Table 7 2024 Electrofishing Survey Locations

Survey Location	Easting	Northing	Survey Type
EF1	248466	783751	Fully-quantitative
EF2	248475	783444	Fully-quantitative
EF3	246237	781277	Fully-quantitative
EF5	249556	784520	Fully-quantitative
EF6	246405	780832	Fully-quantitative

Following each survey, assessment of the species composition, abundance and age class structure of fish fauna was carried out in accordance with SFCC guidelines on undertaking and managing electrofishing operations (SFCC, 2007) and British Standards BS 14011 (sampling of fish with electricity) & BS 14962 (guidance on the scope and selection of fish sampling methods) within fully-quantitative surveys.

All works were administered under Marine Scotland Licence (issued in line with the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 – Sections 27 & 28) and all terms & conditions were adhered to.

Before any fish fauna sampling was carried out, specific risk assessments were prepared and followed during the works. The risk assessments covered other issues such as fish handling protocols for minimising stress, proper use of equipment to minimise potential for damage to fish and other species, biosecurity protocols for disinfection of nets/equipment and numbers of species likely to be present.

The baseline electrofishing surveys were carried out during July 2023. This is within the optimal time of year for survey as salmon and trout young of year have emerged from spawning redds and reached a sufficient size to be safely captured and identified to species level. Water temperatures will also generally be within the optimal range for capture by electrofishing (10 – 15 ◦C). Further electrofishing surveys were carried out during August 2024. These surveys were scheduled following consultation and agreement with SEPA to aid visual identification of any fish specimen still present in the survey locations, notwithstanding that some hatched fish may have already migrated back to the lochs at this point in the year.

The survey team comprised three experienced surveyors on each occasion. The survey lead was qualified to SVQ Level III (leading electrofishing operations and undertaking fish habitat surveys) and both assistants were qualified to SVQ Level II (introduction to electrofishing).

The surveys were undertaken using a Hans Grassl Electrofishing kit which is battery powered and was set up to drive a single anode. Smooth DC current was utilised as this is generally accepted as the least damaging to fish during this type of survey.

Wherever possible, fully-quantitative sampling was the preferred methodology for all sites as it allows for enumeration of a stock, or stock component, within a given site and provides a reasonably accurate estimate of a given population. In sites where the full width of the channel was deemed unsafe for safe wading, or in areas of loch margins semi-quantitative timed surveys were undertaken to determine minimum density. The survey type achieved for each electrofishing survey location is provided in **Table 6** and **Table 7** respectively.

Individuals caught were carefully placed in an aerated freshwater container with a small hand net. Individuals were anaesthetised using 5 ml^{-1} benzocaine solution and fork length (mm) recorded. A sub-sample of fish were photographed for reference. All individuals were released at the upstream limit of the survey location post-processing. A sub-sample of fry were externally verified to species level.

Data Analysis

Species data collected from fully-quantitative survey methods were assessed using a statistical model to identify a population estimate for each survey location. Fish densities were expressed as fish per 100 m^2, and densities were presented separately for fry (0+, young of the year) and parr (1++, fish older than 1 year). The statistical model used for relevant population estimation was Removal Sampling 2 (Seaby and Henderson, 2008), and this was linked to the following method: Constant probability of capture – developed by Zippin (1956). This method takes into account the likelihood that the capture of different individuals within a population is constant. The calculation of the estimated population uses maximum likelihood estimates. The model is less accurate when dealing with low densities of fish. Some brown trout parr densities were so low (i.e. only one or two fish captured) that fully quantitative estimates were unable to be established. Where this was the case, densities are expressed as a minimum estimate of fry or parr per 100 m^2.

The National Fisheries Classification Scheme

The National Fisheries Classification scheme grades, as shown in **Table 8**, is typically used to describe trout fry and parr, as is the industry standard. No such classification currently exists for other species (e.g. Arctic charr and Eurasian minnows).

Table 8 National Fisheries Classification Scheme Grades

Grade	Description	Density (fish/100m^2)	
		Trout fry	Trout parr
F	Absent	0	0.1 – 1.5
E	Very Poor	0.1 – 2.4	1.6 – 3.0
D	Poor	2.5 – 5.2	3.1 – 5.55
C	Fair	5.3 – 12.3	5.6 – 10.3
B	Good	12.4 – 30.2	5.6 – 10.3
A	Excellent	≥ 30.3	≥ 10.4

SFCC Classification Scheme

The Scottish Fisheries Coordination Centre (SFCC) developed a national river classification scheme for Scottish rivers (Godfrey, 2005). The SFCC classification is based on single-run electrofishing events rather than fully-quantitative sampling (density based on number of fish captured during a single electrofishing run at each survey location). The result of only the first run of fully-quantitative electrofishing survey is applied to enable SFCC regional classification. The classifications are based on data sets held by SFCC. The data held for the West Region allows the fish abundance to be analysed in a regional context. Different classifications are provided for different stream widths. The classifications presented in this report are based on stream widths of less than 4 m (EA3 & EA5) and between 4-6 m (EA1, EA2 & EA6).

The SFCC single-run classification methodology produces a result with a lower level of precision than that required to inform a full Environmental Impact Assessment (EIA), where baseline information on fish populations prior to the development will need to be collected, often for a number of years. When providing information for EIAs the SFCC recommends that fully-quantitative sampling is performed. However, SFCC classifications are also provided in this report as a useful analysis in a regional context. No such classification system is available for other species i.e. Eurasian minnow or Arctic charr.

The relevant classifications for the Earba survey locations fall within the West Region and are presented below in **Table 9** for streams of <4 m wide and streams of 4-6 m wide.

The SFCC regional classification scheme was applied to the 2024 results for more detailed analysis of the results in a regional context.

Table 9: SFCC Fisheries Classification Scheme (West Region – no. fish/100 m^2 in streams <4m and 4-6m wide)

Species/ Age-class	Absent	Min to 20th percentile	20th to 40th percentile	40th to 60th percentile	60th to 80th percentile	80th to 100th Percentile
<4 m Wide						
Trout fry 0+	0.0	1.4 - 9.9	9.9 – 28.5	28.5 – 44.7	44.7 – 74.8	74.4 – 181.3
Trout parr 1++	0.0	0.9 – 3.9	3.9 – 5.6	5.6 – 7.6	7.6 – 12.1	12.1 – 66.7
4-6 m Wide						
Trout fry 0+	0.0	0.7 – 3.0	3.0 – 5.0	5.0 – 12.4	12.4 – 19.0	19.0 – 103.5
Trout parr 1++	0.0	0.9 – 2.3	2.3 – 3.3	3.3 – 5.4	5.4 – 8.4	8.4 – 30.3
Description	*Absent*	*Very Poor*	*Poor*	*Moderate*	*Good*	*Excellent*

For full details of 2024 Fish Population surveys, please refer to **Appendix F.**

2.2.6 Fish Population (Gill netting)

The gill netting monitoring strategy employed is that described in Bean (2003)[3], as recommended by Marine Scotland Science advice in the Scoping Opinion for the Section 36 planning application, 'to provide information on the presence and abundance of the different

[3] Bean, C. W. (2003). A standardised survey and monitoring protocol for the assessment of Arctic charr, *Salvelinus alpinus* L., populations in the UK. Scottish Natural Heritage.

fish species'[4]. This was achieved through a combination of targeted NORDIC style multi-mesh gill netting and quantitative hydroacoustics. Swedish standard methods (Appelberg, 2000) were not adopted due to considerable levels of fish mortality and resource intensity required[5].

Two gill net types were used: benthic and pelagic, consistent with the new standard multi-mesh gill nets outlined in Bean (2003). Benthic gill nets consist of twelve panels differing in mesh sizes ranging from 5 – 55 mm (bar mesh size) stretched knot to knot recommended as standard sampling method type. Each gill net measures 30 m in length and 1.5 m in height with each individual mesh panel reaching 2.5 m in length. Pelagic gill nets are similar but exclude the 5 mm mesh size (eleven panels overall) and measure 27.5 m in length and 6 m in height.

Hydroacoustic surveys were initially conducted. Equipment used was the Hummingbird HELIX 9 DI·GPS. A discrete random parallel design was followed for hydroacoustic transects to identify areas where fish were present to guide gill net placement and to identify areas to be excluded (e.g. areas of dense macrophyte growth or large boulders).

The start and end points of each transect were recorded using a handheld GPS in addition to the time taken to complete each transect. The speed of the boat did not exceed 4.0 knots to reduce a flee response from fish and to allow the equipment to work effectively. Additional information including weather condition, water state (Beaufort scale) and potential disturbances (anthropogenic and ecological) were noted. An initial analysis of the hydroacoustic survey was used to dictate gill net location. Additional information is available in **Appendix C**: gill netting subsidiary information.

Gill nets were set in areas where the highest fish density was recorded. Nets were set before dusk and rose before dawn over a minimum 12-hour period (between 22:00-06:30), to ensure sampling covered crepuscular and nocturnal periods (peak Arctic charr activity). Start and end GPS points were taken when deploying gill nets to ensure relocation at a later point. Gill nets were additionally fixed with large, identifiable buoys and appropriate weight anchors to prevent net movement. Two benthic and two pelagic gill nets were used for each loch (four net sample effort). For Loch Earba East and West nets were set over two nights (eight net night sample effort for each basin) due to both basins reaching >50 hectares. It was proposed that Loch Leamhain consisted of a four net night effort over one night.

Gill nets were recovered after 12 hrs and taken ashore for sorting and sampling. Fish were removed from nets as quickly as possible and placed in an aerated water bucket. Data collected includes fish species, abundance, body mass, fork length, fin-clip sample for genetic analysis (sample of individuals) as well as a sample of photographs for morphometric analysis). Fish were released into their appropriate benthic/pelagic habitats after sampling.

Post-fieldwork a condition assessment was undertaken based on the criteria outlined by Bean (2003), based on abundance, population demographic structure and maintenance of habitat quality. For Oligotrophic lochs, such as Loch Earba/Leamhain, unfavourable condition is considered if abundance is less than 37 fish ha^{-1}. Population demographic structure was assessed with favourable condition being achieved if 70% of individuals were within the 0+/1+ category (this is 40-99 mm for charr). Maintenance of habitat quality considered nutrient enrichment, siltation, gravel exposure and loss of spawning substrate; this was supported by ongoing water quality monitoring. If no fish were caught in benthic and/or pelagic environments, nets were re-deployed for an additional 12-hours. All fish were released alive if possible.

Planning for a further gillnetting survey was undertaken during 2024. While a licence was granted for this work, and a suitable contractor appointed, it was not possible to complete this survey prior to the closure of 2024 survey season. The contemporaneous emergence of the results of the 2024 eDNA survey (see below) indicated that the ethical considerations and scientific value of this work likely posed insurmountable barriers to its completion, as it would

[4] Scoping Opinion (2003).
[5] In accordance with consultation with MarineScotland Licencing

have resulted in significant mortality of an already small, and potentially fragile, Arctic charr population.

2.2.7 eDNA

During October 2023, 5 locations were sampled for eDNA around Loch Leamhain, as detailed in **Table 10.**

Samples were filtered using a standard manual hand pump. The pump was rinsed three times with sample water prior to use; water was poured onto the bankside at a distance that would prevent surface run-off reaching the sample location and contaminating water, and increased turbidity.

The pump was filled with water with the initial volume noted. The filter was placed at the end of tubing attached to the pump and secured with cable ties to create an air seal. Water was pumped through the filter until sediment and suspended solids sufficiently clogged the filter paper to reduce water passing through this. The end volume was noted, and total volume passed through the filter calculated. Volume filtered is variable per site due to varying suspended solid load. The pump is then emptied of water and air passed through the filter to remove any excess water.

Filters were placed sealed in centrifuge tubes with silica to remove any excess water/condensation. Care to reduce human DNA contamination was achieved by wearing nitrile gloves and avoiding touching the ends of the filters. Contact with water was additionally avoided.

Two samples (duplicates) were collected at each of the five locations (10 samples in total). These were externally analysed by the University of Glasgow.

Table 10 2023 eDNA sample locations

Sample Number	Easting	Northing	Description	Volume water pumped
1	250570	779352	Allt Loch a' Bhealaich Leamhain	750
2	250466	779397	Outflow of Loch Leamhain	500
3	250384	779404	Loch Leamhain	500
4	250276	779416	Loch Leamhain	500
5	250052	779459	Loch Leamhain	500

During 2024, a further programme of eDNA sampling and analysis was undertaken following consultation with SEPA regarding the methodology and sample quantity to be used. Following consultation with eDNA analysis specialists at the University of the Highlands and Islands' (UHI) Institute of Biodiversity and Freshwater Conservation, eDNA samples were collected from Loch Leamhain and from both basins of Loch Earba. Under advice from UHI, it was considered that sampling during October would enable representative sampling from bankside sampling alone, due to the increased water mixing expected during Autumn/Winter due to the absence of a distinct thermocline within the loch's waters combined with increased water turbulence due to more frequent and stronger winds. A total of 10 samples were collected from each loch, with samples collected at approximately equidistant intervals around the perimeter of each loch, as far as access constraints allowed. Sample locations were selected to avoid the potentially diluting/confounding influence of in-flowing tributaries as far as possible. The sample locations used during the 2024 eDNA sampling programme are detailed in **Table 11** below.

Table 11 2024 eDNA sample locations

Sample Number*	Easting*	Northing*
Loch Leamhain		
1	249442	779731
2	249586	779945
3	250110	779738
4	249846	779895
5	249614	779578
6	250130	779442
7	250425	779401
8	250487	779471
9	250312	779419
10	250409	779559
Loch Earba – West		
11	246384	781321
12	246445	781559
13	248141	783293
14	248191	783412
15	248263	783113
16	248003	782789
17	247309	782002
18	247639	782371
19	247058	781676
20	246722	781909
Loch Earba – East		
21	249167	784091
22	249488	784588
23	249865	785036
24	250007	785339
25	250116	785659
26	250079	785686

27	249916	785501
28	249811	785356
29	249517	785033
30	249084	784561

* The sample location grid references and location identifiers are provisional, pending the issuing of UHI's final report.

The method used during the 2024 eDNA sampling programme was informed and supervised by [redacted], an eDNA specialist from UHI. The method included collecting 1,500ml aggregated water samples into sterile sampling containers. All sampling was conducted from the lochside, with all wading avoided as far as possible. Specific precautions were adopted to prevent the cross-contamination of DNA from sample to sample, and from the samplers themselves to the sampled waters. Two 1,500ml field blanks were also maintained and analysed as a further quality control measure. All samples were transported to UHI's laboratory for filtering and preservation within 24 hours of their collection, in line with Nature Scot guidance. The samples were held in chilled coolboxes from their time of collection until they were unpacked and processed by the receiving laboratory.

The samples were externally analysed by University of the Highlands and Islands, using a 12S vertebrate marker technique.

2.2.8 Macrophytes

The standard approach to biological monitoring of standing water habitats, as recommended by the JNCC was employed for the macrophyte survey (Interagency Freshwater Group, 2015).

Four 100 m transects were conducted per waterbody; this is considered representative where the waterbody area is <100 ha. Where waterbodies are small (<5 ha) less transects are considered sufficient to characterise the waterbody.

Locations of the transects were strategic to characterise macrophyte communities and/or where species of interest are likely to occur (e.g. selection is not random). Where possible, the selection should be based on previous surveys. As historical macrophyte data was not present prior to this survey, transect locations were chosen to represent the potential range of habitats or species within the marginal areas of waterbodies. This was assessed by undertaking an initial walkover of the waterbody perimeter prior to conducting transect surveys. At least one transect should be located in the sheltered part of the shore where plant fragments are likely to accumulate.

A strandline survey and a wader survey were carried out in each waterbody examined.

The strandline survey was incorporated into each 100 m transect recording the presence / absence of species. This was sub-divided into 5 equal sections with presence of species recorded within each section. This did not comprise a formative part of the assessment but was undertaken as a guide to inform the potential presence of charismatic species. In the event wader and /or boat surveys could not be undertaken this may be used in the assessment.

Wader surveys were conducted over the same 100 m transects with five sections surveyed perpendicular to the main transect line at 20 m intervals each covering an area of 1 m^2 (see **Figure 1**). Additional 1 m^2 areas were surveyed at depths of 0.25 m, 0.5 m, 0.75 m and >0.75 m. A bathyscope and/or grapnel hook was used to examine the species present at each sampling point. The following data was recorded from each transect:

I. All species present;
II. An estimate of total abundance using the DAFOR scale (see **Table 8**); and
III. A photograph of a selection of species identified for future reference.

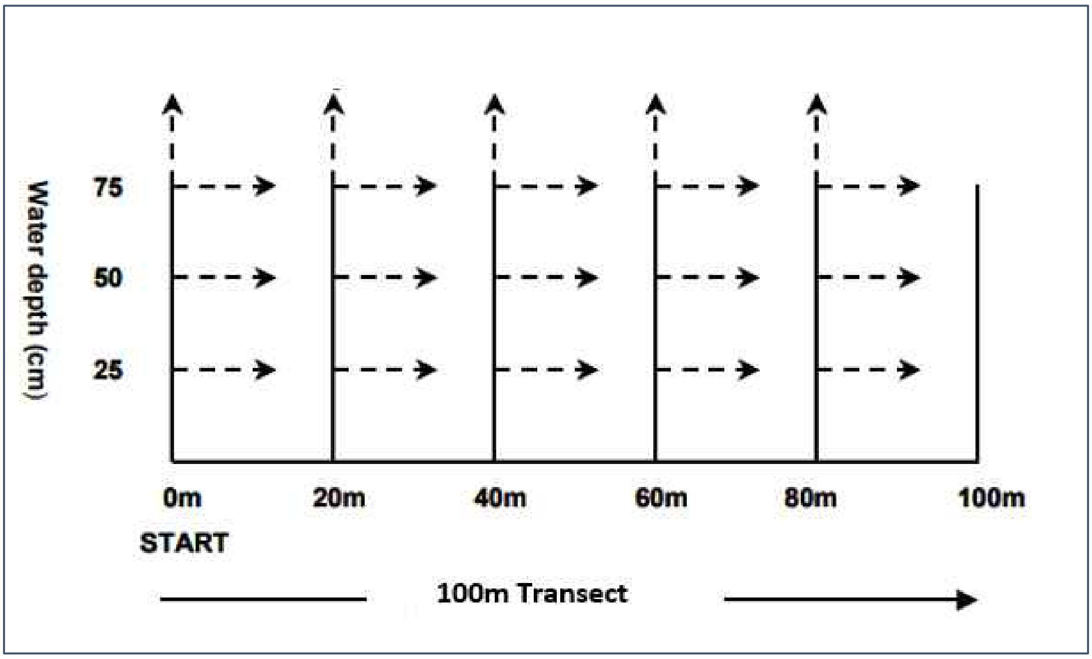


Figure 1. The location of Survey Sections Relevant to the 100 m Transect (Interagency Freshwater Group, 2015).

DAFOR abundance categories were given to each species identified based on the percentage coverage within each transect, as shown in **Table 12**. This provides a comparable base for future surveys to identify growth / reduction in species coverage in addition to species present.

Table 12 DAFOR Abundance Category

Abundance		Cover
D	Dominant	50-100%
A	Abundant	30-50%
F	Frequent	15-30%
O	Occasional	5-15%
R	Rare	<5%

Boat surveys were not conducted as part of this survey. Grapnel hooks were used to obtain samples where water depth was >5 m.

Additional information such as the water level, or reference photos of the water level relative to fixed structures should be taken. Photos of rare or unknown plants were taken for future reference. Future macrophyte surveys should be conducted under similar water levels to ensure compatibility of results.

Conservation statuses for plants was assessed via the Botanical Society of Britain & Ireland (2023) latest 'List of Conservation Statuses for all UK Plants'.

2.2.9 Limitations to Surveys

Gillnetting

An attempt was made to carry out gillnetting on Loch Leamhain in Autumn 2023 but access and weather constraints prevented this on the grounds of health and safety. As a result, eDNA (qPCR) analysis was conducted to establish the presence of Arctic charr. Additionally, extremely adverse weather, compromising safety, on Loch Earba West prevented the deployment of a single pelagic gill nets; seven net nights in total were ultimately conducted.

The Bean (2003) gillnetting methodology was limited in that it targeted waterbody populations of Arctic charr, and does not account for the potential presence of Arctic charr in both waterbodies and adjoining tributaries (which is not common in Scotland). Consequently, it could not be established whether 70% of individuals were within the 0+/1+ category (40-99 mm for Arctic charr) as juveniles were present in the adjoining tributaries rather than the waterbody and therefore not detectable by gillnetting. Additionally, there is currently no alternative methodology to incorporate both waterbody and watercourse data to determine favourable condition. As such favourable condition could only be assessed on abundance (ha^{-1}) and maintenance of habitat quality.

Macrophytes

Rising water levels of Loch Earba East and West during macrophyte surveys likely obscured some submerged/floating plant species, as such they may be underrepresented in this report. It is recommended that macrophyte surveys are repeated during summer optimal periods to assess species assemblages in optimal survey periods.

Electrofishing

Due to some watercourses being unsuitable for electrofishing at the time of survey in 2023, semi-quantitative electrofishing was conducted on waterbody margins as compensatory sites.

Due to visual similarities of salmonids at the youngest life stages (fry) (<50mm length), not all individuals captured during 2023 electrofishing surveys could be practicably identified to species level (either Arctic charr or brown trout). Photographs of a sample of three individual specimen were externally checked, suggesting the possible presence of both Arctic charr and brown trout within survey results, which gave rise to uncertainty of the identification of the fish captured. Consequently, population abundance could not be established for either species (only presence). Resultingly, population abundance for 2023 (as described in **Table 6**) was calculated using all salmonids present.

3 Results

3.1 Macroinvertebrates

Macroinvertebrate indices scores are shown in **Table 13** for Spring sampling. Full species list is provided in **Appendix B**.

Survey Locations MS02, MS03, MS04, MS05, MS06, MS07, MS08 and MS10 are within the proposed inundation zone. Survey Locations MS01 and MS09 are outwith the inundation zones.

Table 13. Macroinvertebrate Indices Scores Spring Samples

Biotic Index	Survey Location									
	MS01	MS02	MS03	MS04	MS05	MS06	MS07	MS08	MS09	MS10
BMWP (TL1)	118	82	75	22	85	37	64	100	70	123
NTAXA (TL1)	18	13	11	5	12	6	10	17	12	18
ASPT (TL1)	6.56	6.31	6.82	4.40	7.08	6.17	6.40	5.88	5.83	6.83
LIFE (TL5)	7.88	8.69	8.75	8.50	8.53	6.00	7.88	8.43	8.73	8.61
LIFE(FAM) (TL2)	7.44	8.18	8.20	6.67	7.91	6.33	7.11	7.53	7.5	7.65
PSI (TL5)	66.67	100.00	100.00	100.00	100.00	37.50	75.00	75.00	100.0	92.50
PSI(FAM) (TL3)	77.27	95.00	94.44	100.00	94.44	71.43	84.62	75.00	88.24	87.50
E-PSI (FAM)	93.82	100.00	100.00	100.00	100.00	53.55	98.04	90.51	100.00	99.29
E-PSI (TL5)	89.78	100.00	100.00	83.33	100.00	63.13	81.23	90.81	100.00	98.00
CCI (TL5)	11.67	4.62	6.00	17.50	10.36	8.40	12.50	14.00	5.10	9.41
WHPT (TL2)	125.8	99.8	83.1	25.1	92.6	33.2	76.3	129.2	83.2	144.5
NTAXA (TL2)	18	14	11	5	12	6	10	18	12	18
ASPT (TL2)	6.99	7.13	7.55	5.02	7.72	5.53	7.63	7.18	6.93	8.03

Spring macroinvertebrate samples ranged in BMWP score category from Very Good (MS01, MS10); Good (MS02, MS03, MS05, MS08); Moderate (MS07, MS09); to Poor (MS04, MS06) throughout all Survey Locations.

CCI scores ranged from High Conservation Value (MS04); Fairly High Conservation Value (MS01, MS05, MS07, MS08); Moderate Conservation Value (MS02, MS06, MS09, MS10).

PSI scores ranged from Sedimented (MS06); Slightly Sedimented (MS01, MS07, MS08); and Minimally Sedimented (MS02, MS03, MS04, MS05, MS09, MS10).

The EPSI index indicated overall minimal amounts of fine sediments with the exception of MS06 that contained significant amounts.

Macroinvertebrate indices scores are shown in **Table 14** for Summer sampling. Full species list is provided in **Appendix B**.

Table 14. Macroinvertebrate Indices Scores Summer Samples

Biotic Index	Survey Location									
	MS01	MS02	MS03	MS04	MS05	MS06	MS07	MS08	MS09	MS10
BMWP (TL1)	73	125	85	19	123	25	79	122	69	80
NTAXA (TL1)	12	20	13	5	19	5	13	19	9	13
ASPT (TL1)	6.08	6.25	6.54	3.80	6.47	5.00	6.08	6.42	7.67	6.15
LIFE (TL5)	7.33	8.10	8.42	N/A	8.24	6.00	7.67	8.73	8.55	8.67
LIFE(FAM) (TL2)	7.20	7.28	7.82	6.33	7.41	6.50	6.82	7.71	7.44	7.45
PSI (TL5)	46.15	90.70	100.00	66.67	91.49	28.57	63.16	95.24	100.00	93.33
PSI(FAM) (TL3)	73.33	80.00	100.00	100.00	90.00	60.00	71.43	82.86	92.31	84.21
E-PSI (FAM)	100.00	98.62	100.00	100.00	99.33	75.33	85.17	97.16	100.00	99.08
E-PSI (TL5)	89.87	94.79	100.00	100.00	100.00	100.00	87.94	95.42	100.00	97.29
CCI (TL5)	5.57	11.43	5.10	0.00	12.11	1.50	10.56	14.00	5.40	25.45
WHPT (TL2)	66.3	144.2	101.9	27.2	139.6	22.2	80.8	151.9	76	94.6
NTAXA (TL2)	12	21	14	6	20	5	13	20	10	13
ASPT (TL2)	5.53	6.87	7.28	4.53	6.98	4.44	6.2	7.60	7.60	7.28

Summer macroinvertebrate samples ranged in BMWP score category from Very Good (MS02, MS05, MS08); Good (MS01, MS03, MS07, MS10); Moderate (MS09); to Poor (MS04, MS06) throughout all Survey Locations.

CCI scores ranged from Very High Conservation Value (MS10); Fairly High Conservation Value (MS02, MS05, MS07, MS08); Moderate Conservation Value (MS01, MS03, MS09); and Low Conservation Value (MS04, MS06).

PSI scores ranged from Sedimented (MS06); Slightly Sedimented (MS01); Slightly Sedimented (MS04, MS07); and Minimally Sedimented (MS02, MS03, MS05, MS08, MS09, MS10).

The EPSI index indicated overall minimal amounts of fine sediments with slightly elevated values at MS06.

3.2 Water Quality

Water quality results are shown in **Table 15** on the following page.

Table 15. Water Quality Results

	Temperature (°C)		pH		Electrical Conductivity (µS/cm)		Total Dissolved Solids (mg/L)		DO(%)		Do (mg/L)		ORP (mV)	
Visit Number	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
WQ1	11.3	9.7	7.2	7.7	23	31	15	18	108.8	100.8	11.6	10.7	130.7	108.9
WQ2	11.1	8.2	7.2	6.4	49	22	34	13	110.0	104.4	11.7	11.4	140.2	179.4
WQ3	10.3	/	7.3	/	52	/	35	/	106.2	/	11.6	/	131.8	/
WQ4	10.6	8.9	7	6.4	33	17	19	10	107.8	100.0	11.8	10.9	152.3	170.3
WQ5	11.1	11.9	6.2	6.4	24	17	13	14	105.1	104.1	11.0	10.7	136.1	155.7
WQ6	9.6	11.5	6.6	6.3	22	26	14	14	106.5	103.3	11.8	10.5	163.7	171.5
WQ7	10.2	10.4	6.3	6.1	41	17	26	11	89.6	104.5	9.8	10.1	145.8	147.2
WQ8	10.0	9.3	6.7	6.8	29	14	18	9	108.8	103.0	11.9	11.2	109.6	114.2
WQ9	9.3	/	6.5	/	20	/	14	/	106.1	/	11.8	/	136.1	/
WQ10	8.8	/	6.8	/	27	/	18	/	105.1	/	11.7	/	115.2	/
WQ11	11.3	9.9	7.0	6.4	24	23	16	14	108.2	103.3	11.5	10.6	139.4	146.3
WQ12	8.7	/	7.9	/	46	/	29	/	104.5	/	12.5	/	116.9	/
WQ13	/	7.1	/	7.8	/	18	/	12	/	103.5	/	11.4	/	161.5
WQ14	/	9.6	/	7.5	/	22	/	16	/	101.6	/	10.4	/	128.5

Within Visit 1 Temperature ranged from 8.7°C (WQ12) to 11.3°C (WQ01), with an average of 10.18°C.

The pH ranged from 6.2 (WQ05) to 7.9 (WQ12), with an average of 6.89.

Electrical conductivity (μS/cm) ranged from 20 μS/cm to 52 μS/cm, with an average of 32.5 μS/cm.

Total dissolved solids (TDS) (mg/l) ranged from 13 mg/l to 35 mg/l, with an average of 20.92 mg/l.

Dissolved oxygen (DO as %) ranged from 89.6% to 110%, with an average of 105.5%. Dissolved oxygen (DO as mg/l) ranged from 12.5 mg/l to 9.8 mg/l, with an average of 11.56 mg/l.

Oxidative reduction potential (ORP) (millivolts (mV)) ranged from 109.6 mV to 163.7 mV, with an average of 134.82 mV.

Within Visit 2 Temperature ranged from 7.1°C (WQ) to 11.9°C (WQ), with an average of 9.65°C.

The pH ranged from 6.1 (WQ) to 7.8 (WQ), with an average of 6.78.

Electrical conductivity (μS/cm) ranged from 14 μS/cm (WQ) to 31 μS/cm (WQ), with an average of 20.7 μS/cm.

Total dissolved solids (TDS) (mg/l) ranged from 9 mg/l (WQ) to 18 mg/l (WQ), with an average of 13.10 mg/l.

Dissolved oxygen (DO as %) ranged from 100% (WQ) to 104.5% (WQ), with an average of 102.85%. Dissolved oxygen (DO as mg/l) ranged from 10.1 mg/l (WQ) to 911.4 mg/l (WQ), with an average of 10.79 mg/l.

Oxidative reduction potential (ORP) (millivolts (mV)) ranged from 108.9 mV (WQ) to 179.4 mV (WQ), with an average of 148.35 mV.

3.3 Fish Habitat

Fish habitat surveys indicated a dominance of Productive habitat type (91.46% of surveyed area). Within Productive habitat types Productive (moderate) displayed highest abundance (69.65%), followed by Productive (low) (19.34%) and Productive (high) (2.47%). Habitat lengths (m) and their percentage of surveyed area is presented in **Table 16**, refer to **Table 4** for Habitat descriptions.

Not Suitable habitat comprised 8.31% of total surveyed area. Lamprey habitat comprised the lowest habitat type at 0.23%.

No extensive areas of bedrock or bedrock channels were identified during the habitat survey.

Table 16. Riverine Habitat Lengths

Habitat Type	Total Length (m)	Percentage of Total Habitat Assessed	Length Lost (m)
Productive (high)	267	2.47	267
Productive (moderate)	7538	69.65	1459.4
Productive (low)	2131	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

A total habitat loss of 2,694.6 m is predicted under maximum inundation levels (see **Appendix A, Figure 3-7)**, this represents 24.9% of surveyed area.

Productive habitat loss is predicted to be greatest at 267 m, 1,459.4 m and 498.3 m for Productive (high), Productive (moderate) and Productive (low) respectively.

A total loss of 496.9 m of Not Suitable habitat is also predicted.

No loss of bedrock and lamprey habitat is predicted.

3.3.1 Obstacles

Numerous obstacles to upstream movement of fish were identified on watercourses assessed, which are summarised in **Table 17**. The majority of obstacles were natural, comprised of waterfalls, rapids or chutes, however, anthropogenic obstacles were present in the form of dams with no fish passes.

Several watercourses, e.g. Allt Coire Pitridh, were categorised by a large number of passable and semi-passable (under certain flows) obstacles.

Table 17. Obstacles identified during the habitat survey

Number	Watercourse	British Grid Reference		Type	Notes
		Easting	Northing		
1	Tributary of Allt Coire a Chlachair	246529	780427	Series of impassable obstacles	Majority of watercourse categorised by small sequential obstacles due to steep gradient
2	Allt Coire Pitridh	246881	780457	Impassable obstacles	Majority of watercourse categorised by small sequential obstacles due to steep gradient
3	Connective river between Loch Earba Basins	248442	783730	Dam	Dam separating Loch Earba East and West, no fish pass information available
4	Allt Labrach	250131	785728	Dam	Dam at outflow of Loch Earba East, no fish pass information available

Number	Watercourse	British Grid Reference		Type	Notes
		Easting	Northing		
5	Unnamed tributary (Loch Earba East)	249245	784698	Culvert	Poorly installed stone culvert with no flow immediately by Loch Earba East waters edge.
6	Allt Labrach	250429	786342	Impassable obstacles	Large impassable obstacles in succession of several smaller obstacles
7	Moy Burn	248851	783280	Impassable obstacles	Large obstacles
8	Moy Burn	248941	783219	Series of impassable obstacles	Bedrock chute with large, eroded steps, water flow was minimal. Additional large waterfalls noted on OS map upstream of survey area at: 249242, 781597 and 249484, 781761
9	Unnamed tributary (Loch Earba East)	249698	784428	Impassable obstacles	Two large impassable obstacles at confluence of tributaries
10	Allt Coire a Chlachair	246282	780262	Boulder obstruction	Multiple boulders with water passing through, no opportunities for fish to pass through
11	Unnamed tributary (Loch Leamhain)	249431	779904	Steep gradient	Extremely steep gradient interspersed with small obstacles

3.3.2 Spawning habitat

Numerous areas of optimal spawning were identified throughout the site, as shown in **Table 18**. Overall availability of optimal spawning substrate throughout the surveyed areas was limited in both occurrence and area.

Table 18. Optimal Spawning Areas

Number	Watercourse	British Grid Reference		Notes
		Easting	Northing	
1	Connective river between Loch Earba Basins	248596	783927	Smaller interspersed areas of well washed optimal gravel/pebble on inside corners of meanders
2	Connective river between Loch Earba Basins	248476	783759	Large areas of well washed optimal gravel/pebble
3	Moy Burn	248589	783414	Small patches of suitable spawning substrate interspersed with drops in gradient
4	Allt Loch a' Bhealaich Leamhain	250469	779395	Optimal stretch of well-washed gravel/pebble at outflow of Loch Leamhain
5	Allt Coire Pitridh	246244	781147	Small areas of exposed gravel bank likely useable during winter spawning periods

Areas where optimal spawning was identified, e.g. number 1 and 3 in Table 15, occurred as small patches of optimal substrate spread throughout a larger area and not occurring as a single spawning bed. Such areas were primarily located in the inside bends of watercourses where water velocity was slower (and deposition of smaller substrate is more prominent). Several identified areas where wholly or partially exposed, however, due to lower water levels at the time of survey (May), areas will likely be immersed during winter spawning periods and have thus been included.

3.3.3 Loch Spawning Habitat Assessment

The results of the 2024 Arctic charr specific spawning habitat assessment indicate that a small minority of the locations assessed provide optimal habitat for Arctic charr spawning. The proportion of the 15m perpendicular transect spawning habitat classifications are provided in **Table 19** below. The proportion of the 50m 'spot check' spawning habitat classifications are provided in **Table 20** below.

Table 19 Transect Data (15m)

Classification	Length (m)	Percentage
Optimal	154	21%
Sub-Optimal	82	12%
Poor	477	67%
Total	**713**	**100%**

Table 20 Point Location Data (50m Spot Checks)

Classification	No. of Points	Percentage
Optimal	1	0.83%
Sub-Optimal	2	1.67%
Poor	117	97.5%
Total	**120**	**100%**

A secondary analysis undertaken on the spawning habitat assessment survey data to take account of the potential for loch water level reductions due to the current operational regime of the existing Ardverikie hydroscheme. The results of this analysis indicates that a majority (56%) of the survey habitat transect length lies above the level of the lowest allowable water level. Under a reasonable worst case scenario, a significant proportion of the optimal and sub-optimal habitat may be exposed by falling water levels following spawning. The results of the secondary analysis are presented in **Table 21** below.

Table 21 Secondary Analysis of Transect Data (15m)

Classification	Length (m) (Within)	Percentage (Within)	Length (m) (Outwith)	Percentage (Outwith)	Combined length (m)
Optimal	45.6	6.4%	108.6	15.2%	154.2
Sub-Optimal	12.6	1.8%	69.2	31.3%	81.8
Poor	254.1	35.6%	222.8	9.7%	476.9
Sub-total	**312.3**	**43.8%**	**400.6**	**56.2%**	**712.9**

* 'Within' and 'Outwith' in this context refers to whether the surveyed habitat is within the minimum water level, or outwith the minimum water level of the existing hydroscheme.

The results of the spawning habitat assessment are based on the loch conditions at the time of the assessment survey taking place (during which, loch levels were relatively high). As indicated in **Table 21** above, it his highly likely that some areas classified as 'optimal' habitat based on the primary survey will in practice not offer viable spawning habitat due to potential water level reductions which may occur following spawning as a result of the effects of the existing hydropower scheme on water levels in the lochs.

3.4 Fish Population (Electrofishing)

3.4.1 2023 Electrofishing Results

Results of the 2023 electrofishing are provided in **Table 22** and shown as population density estimates. Electrofishing Survey Locations are shown in **Appendix A, Figure 8**.

Results of full-quantitative surveys indicate low population densities ranging from 0.03 fish per m^2 (EA3) to 0.81 fish per m^2 (EA5).

Results of semi-quantitative surveys indicate higher population densities ranging from 1.5 - 4.8 fish per m^2. Three Survey Locations (EA7 – EA9) indicated no presence of fish.

Two species were definitively identified via electrofishing: brown trout and Eurasian minnow (*Phoxinus phoxinus*).

Small specimens (<50mm) were collected from a stream draining into west Earba, visually 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. Subsequent eDNA analysis in 2024 of water samples from western Loch Earba did not detect Arctic charr, despite a robust sampling strategy, this 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 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.

Table 22 2023 Electrofishing Population Estimates

Survey Location	Fully-Quantitative Population Estimate (fish per m^2)	Semi-Quantitative Population Estimate (fish per minute fished)	Species Present
EA1	N/A	1.5	Brown trout, Eurasian minnow
EA2	N/A	4.8	Brown trout, Eurasian minnow, possible Arctic charr
EA3	0.03	N/A	Brown trout, Eurasian minnow, possible Arctic charr
EA4	0.12	N/A	Brown trout, possible Arctic charr
EA5	0.81	N/A	Brown trout, Eurasian minnow
EA6	0.08	N/A	Brown trout, Eurasian minnow
EA7	N/A	0	N/A
EA8	N/A	0	N/A
EA9	N/A	0	N/A

Fish size distributions are provided for brown trout and Arctic charr (combined) in **Table 23**.

Table 23 2023 Electrofishing Salmonid Fish Size Distribution

Survey Location	Minimum Size (mm)	Maximum Size (mm)	Average Size (mm)
EA1	42	75	47.50
EA2	35	90	54.33
EA3	33	85	50.33
EA4	40	142	84.30
EA5	36	91	48.08
EA6	49	77	63.20
EA7	0	0	0
EA8	0	0	0
EA9	0	0	0

3.4.2 2024 Electrofishing Results

Results of the 2024 electrofishing are provided in **Table 24** and shown as population density estimates. Electrofishing Survey Locations are shown in **Appendix F, Figure 1**.

Two species were identified via electrofishing: brown trout and Eurasian minnow (*Phoxinus phoxinus*). No Arctic charr were detected during the 2024 electrofishing surveys during fish processing in the field. Photographs of all the fish captured were sent to [redacted] for external verification. The feedback received was that "*none of the fish [captured during the 2024 surveys] are unequivocally Arctic charr"*, however [redacted] does also note that *"fish under 50 mm* (fork length measurement) *are a bit tricky to be very confident on than larger individuals and there [are] a few of these."*

Note: P[redacted]' phraseology above may give a greater impression than intended that Arctic charr were present within the photographic review of the 2024 electrofishing specimens on account of how the enquiry was worded to him. What [redacted]' intended was that 'none of the fish are unequivocally Arctic charr, therefore they are more likely to be Brown trout' within the recognised difficulties of visually speciating fish specimens of this size class.

The 2024 assessment was therefore made on the assumption that all of the salmonid fish captured were brown trout in order to determine population estimates.

Brown trout fry (0+) were present at survey locations EA1 – EA6. Brown trout parr (1++) were present at survey locations (EA2, EA3, EA5 and EA6) but absent from EA1, possibly due to a lack of bankside cover and large substrate which provides instream cover for larger fish.

Fully quantitative population estimates for brown trout fry (0+) ranged from 6.1 per 100m^2 (EA3) to 58 per 100m^2 (EA5). For brown trout parr (1++), most densities captured were low therefore some of the results could not be applied to the statistical depletion model (EA1, EA3 & EA5). These densities are expressed as a minimum estimate. Fully quantitative density estimates for brown trout parr ranged from 4.2 per 100 m^2 (EA2) – 8.3 per 100 m^2 (EA6). Including minimum density estimates, densities ranged from absent (EA1) to 8.3 per 100 m^2 (EA6).

Table 24 2024 Electrofishing population estimates

Survey Location	Survey Technique and Sample Area	Species Recorded and Abundance	Fully-Quantitative Population Estimate	Single-Run Density Estimate
EA1	Fully Quantitative (~97.5 m^2)	Brown trout 0+: 17 Brown trout 1++: 0 Eurasian minnow: 9	Trout 0+: 31.6 Trout 1++: 0.0	Trout 0+: 7.2 Trout 1++: N/A
EA2	Fully Quantitative (95.4 m^2)	Brown trout 0+: 22 Brown trout 1++: 4	Trout 0+: 25.8 Trout 1++: 4.2	Trout 0+: 13.6 Trout 1++: 3.1
EA3	Fully Quantitative (~101.5 m^2)	Brown trout 0+: 6 Brown trout 1++: 1 Eurasian minnow: 4	Trout 0+: 6.1 Trout 1++: 1.0	Trout 0+: 3.9 Trout 1++: 1.0
EA5	Fully Quantitative (~101.25 m^2)	Brown trout 0+: 45 Brown trout 1++: 2 Eurasian minnow: 10	Trout 0+: 58.0 Trout 1++: 2.0	Trout 0+: 20.9 Trout 1++: 1.0
EA6	Fully Quantitative (~100.5 m^2)	Brown trout 0+: 10 Brown trout 1++: 5	Trout 0+: 11.7 Trout 1++: 8.3	Trout 0+: 6.0 Trout 1++: 3.0

SFCC regional classification scheme ratings for brown trout fry ranged from *Very Poor (EA3)* to *Poor* (EA5) to *Moderate* (EA1 & EA6) to *Good* (EA2) and for brown trout parr ranged from *Absent* (EA1) to *Very Poor* (EA3 and EA5) to *Poor* (EA2 & EA6). Stream width has a bearing on the SFCC classification with stream widths of <4 m requiring much higher densities to achieve *Moderate* / *Good* / *Excellent* classification status than stream widths of 4-6 m.

Table 25 SFCC Fisheries Classification Scheme Ratings (August 2024)

Survey Location	Trout 0+:	Trout 1++:
EA1	*Moderate*	*Absent*
EA2	*Good*	*Poor*
EA3	*Very Poor*	*Very Poor*
EA5	*Poor*	*Very Poor*
EA6	*Moderate*	*Poor*

3.5 Fish Population (Gillnetting)

In total 185 fish were caught via gillnetting effort (15 net nights). Gillnetting catch effort per species per waterbody is provided in **Table 26.**

Within Loch Earba East a total of 80 individuals were identified comprising three species: brown trout (71); Arctic charr (4); and Eurasian minnow, *Phoxinus phoxinus* (5).

Within Loch Earba West a total of 105 individuals were identified comprising two species: brown trout (103); and Eurasian minnow (2).

Brown trout was the dominant species in both Loch Earba East and West, comprising 88.75% and 98.10% respectively.

Table 26 Gillnetting catch effort per waterbody

Waterbody	Brown trout	Arctic charr	Minnows
Loch Earba East	71	4	5
Loch Earba West	103	0	2
Total:	174	4	7

A comprehensive summary of net effort is provided in **Appendix C**.

Within Loch Earba East brown trout, Arctic Charr and minnows, *Phoxinus phoxinus*, were the sole species identified. Fork length of brown trout varied considerably from 60 – 500 mm in Loch Earba East, with an average of 209.53 mm. One fish at 500 mm was the largest recorded on site.

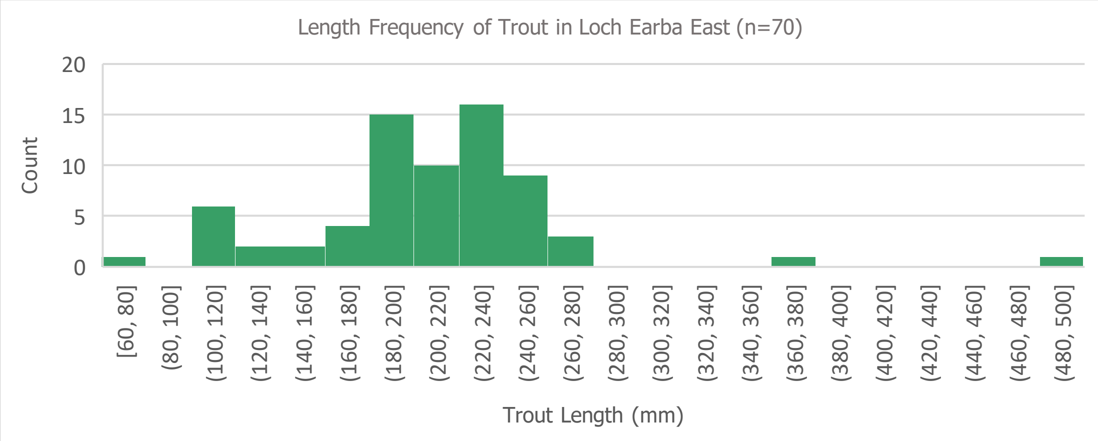


Figure 2. Trout Length Frequency Loch Earba East

Within Loch Earba West brown trout and minnows, *Phoxinus phoxinus*, were the sole species identified. Fork length of brown trout varied considerably from 80 – 300 mm in Loch Earba West, with an average of 186.37 mm.

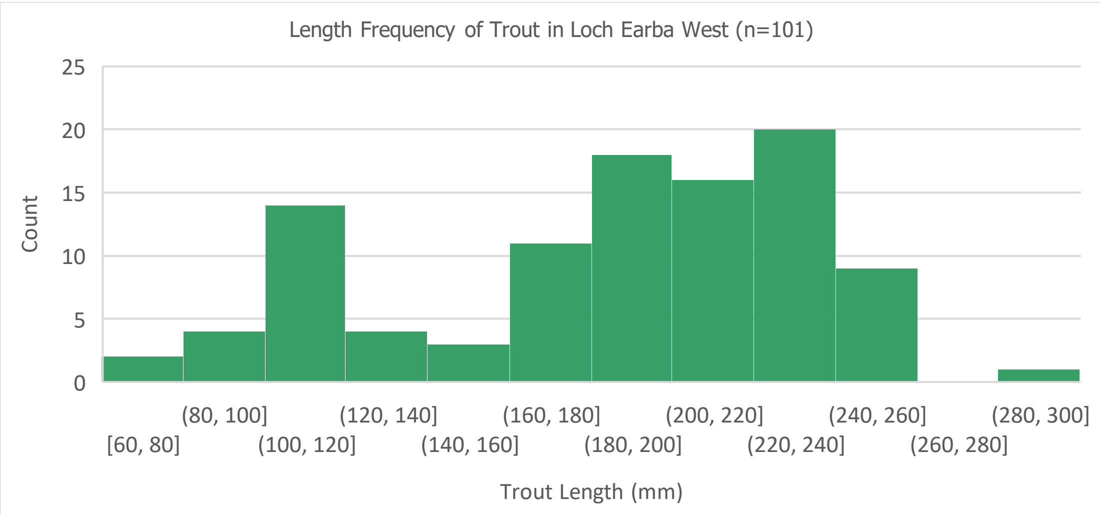


Figure 3. Trout Length Frequency Loch Earba West

3.5.1 Arctic Charr Condition Assessment

Arctic charr condition assessment is comprised of three factors: abundance; population demographic; and maintenance of habitat quality.

Abundance was considered to be in unfavourable condition in both waterbodies. Loch Earba East had a population abundance of 0.07 ha^{-1}, and therefore below the 37 fish ha^{-1} outlined in Bean (2003).

Individuals ranged in length from 114 – 156 mm, therefore outwith the 0+/1+ category (this is 40-99 mm for Arctic charr). Consequently, the criteria of 70% of individuals being within the 0+/1+ category was not achieved; therefore population demographic is considered to be unfavourable. It should be noted that individuals were tentatively identified between the 0+/1+ category during electrofishing, however, percentage of total population cannot be quantified due to the methodology adopted not accounting for presence both in waterbodies and watercourses.

Current maintenance of habitat quality is considered sub-optimal due to existing hydroscheme developments on both waterbodies resulting in unstable loch margins and unnatural water regimes. Gravel substrate on loch margins is regularly exposed as a result of fluctuating water level due to the presence of a hydroscheme affecting both loch basins. Spawning areas are currently unknown in all waterbodies, consequently loss and/or maintenance of spawning substrates cannot be ascertained. Water quality was undertaken on loch margins and connected watercourses and thus do not account for typical deep water Arctic charr habitat, however, no constraints were identified.

No Arctic charr were detected via gillnetting in Loch Earba West. Due to the potential presence of Arctic charr fry in the Moy Burn and the Allt Coire Pitridh, connected only to the West basin, for the purposes of this assessment it is considered that Arctic charr are present in densities above zero fish ha^{-1} and lower than detection capabilities for survey effort employed. Consequently, if Arctic charr are present in very low densities in Loch Earba West, they are considered to be in unfavourable condition.

Arctic charr caught did not appear to display polymorphism (two or more distinct morph groups), however, sample sizes were too low to confirm only one morph is present.

Overall, Arctic charr failed 2/3 criterion for favourable condition in both Loch Earba East and Loch Earba West.

3.6 eDNA

The 2023 eDNA results did not detect the presence of Arctic charr in any water samples assessed, when compared to a positive sample of Arctic charr. **Figure 4** illustrates minimal amplification of Arctic charr eDNA when compared to a positive Arctic charr tissue sample (from Loch Ard Achadh). Presence or absence of Arctic charr could not be determined in Loch Leamhain due to being lower than the limit of detection.

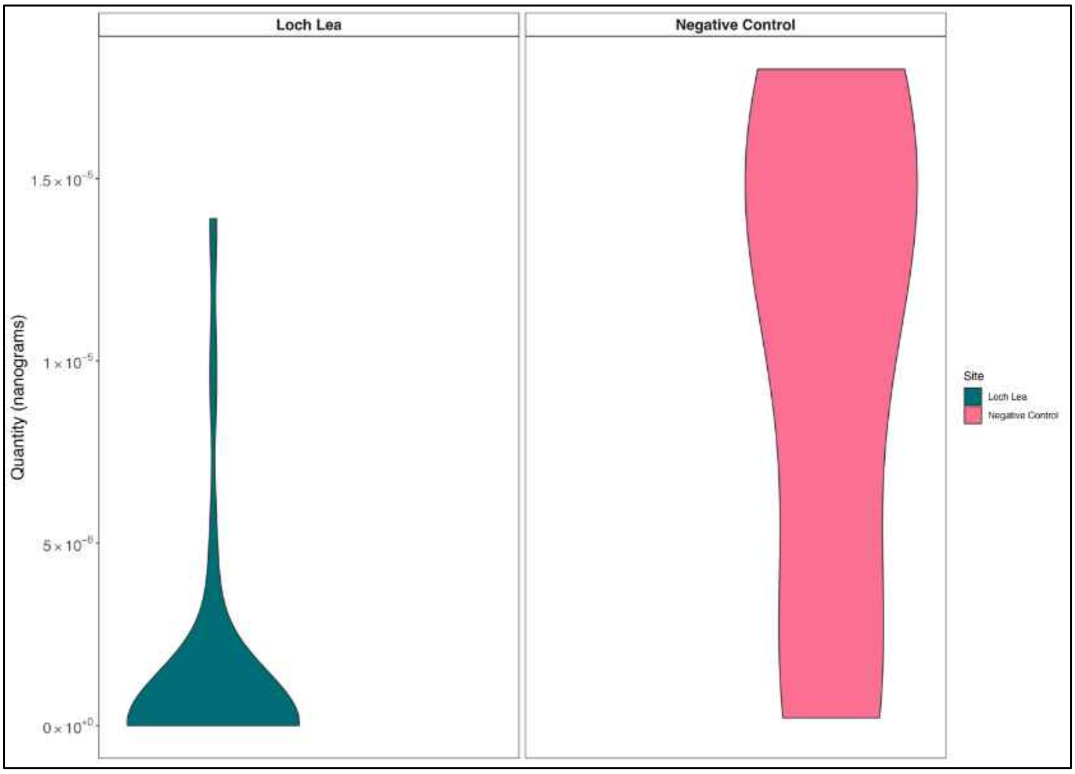


Figure 4. 2023 eDNA results

During the 2024 eDNA survey, a total of three fish species were detected within Loch Leamhain and the two Loch Earba basins. These were Brown trout (Salmo trutta), Eurasian minnow (*Phoxinus Phoxinus*) and Arctic charr (*Salvelinus alpinus*). Brown trout and Eurasian minnow were detected at all sample locations within both Loch Earba basins. Only Brown trout were detected in Loch Leamhain, with positive detection at all sample locations. Arctic charr were only detected within Loch Earba East, positive detections were recorded at only four of the ten locations sampled. **Figure 5** below presents a visual summary of these findings.

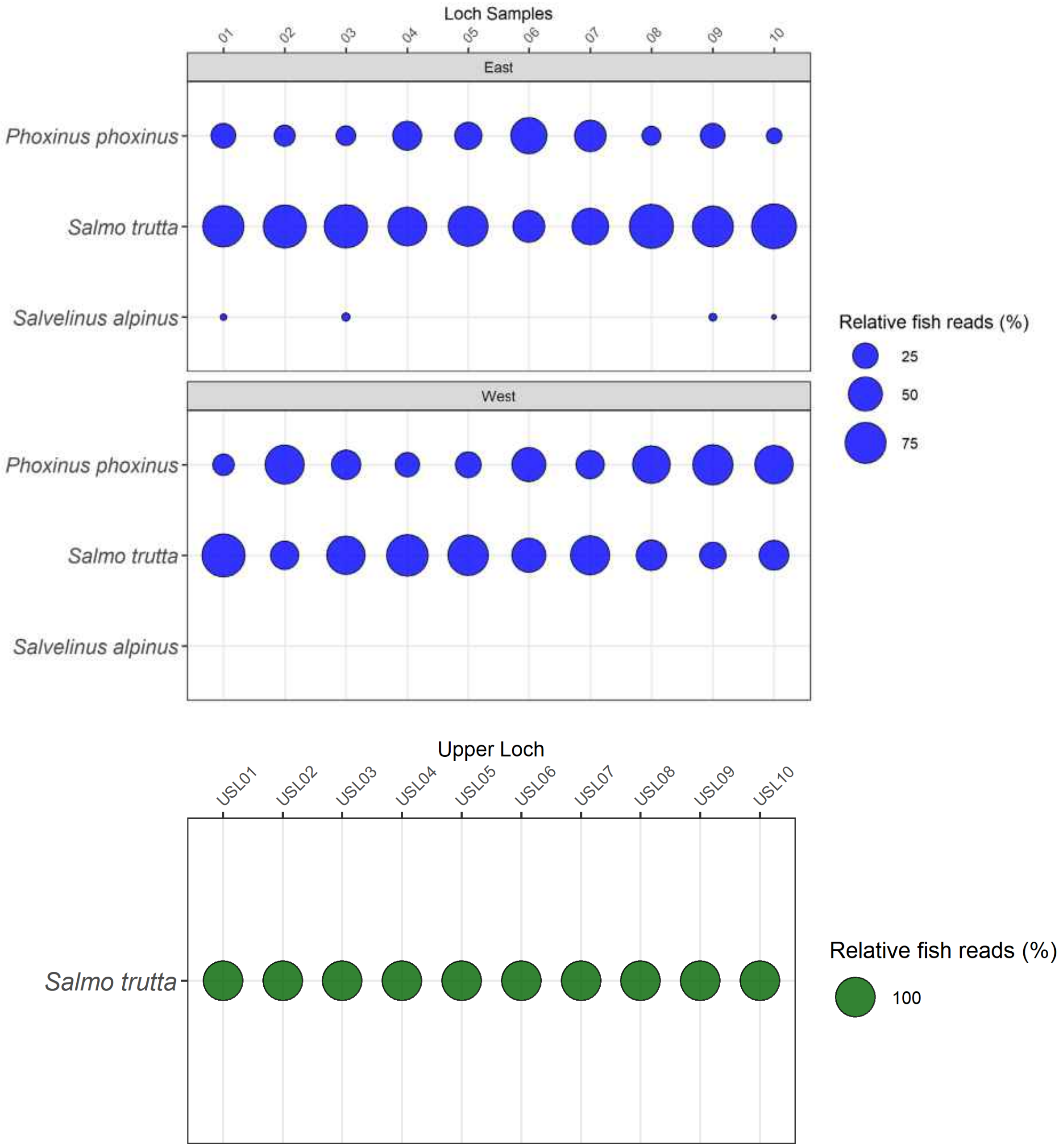


Figure 5. 2024 summary eDNA results

For full details of the 2024 eDNA surveys, refer to the Preliminary Presentation in **Appendix G**.

3.7 Macrophytes

In total 37 species were identified throughout the three waterbodies sampled: 17 submerged/floating; and 22 emergent/edge species (*Isolepis setacea* and *Littorella uniflora* were identified in both submerged and emergent communities). A full species list is provided in **Table 27**.

No invasive non-native species were identified in any of the lochs sampled.

Within Loch Earba East 26 species were identified, 13 submerged species and 13 emergent species.

Within Loch Earba West 18 species were identified, 1 submerged species and 17 emergent species. All species were classified as 'Least Concern' or 'Data deficient' for their conservation value.

Within Loch Leamhain 5 species were identified, 3 submerged species and 2 emergent species. All species were classified as 'Least Concern' or 'Data deficient' for their conservation value.

National vegetation communities around the lochs are generally dominated by wet heath M15 *Scirpus cespitosum-Erica tetralix* wet heath.

Loch Earba has extensive wet heath on the north side down to the loch edge with patches of unimproved grassland, mainly U4 *Festuca ovina-Agrostis capillaris-Galium* saxatile with occasional patches of blanket bog M17 *Scirpus cespitosum-Erioporum vaginatum* blanket mire. There are patches of swamp S9 *Carex rostrata* swamp and S10 *Equisetum fluviatile* swamp at the west end of Loch Earba where the river flows into the loch.

Loch Leamhain is a higher loch with M15 and some more base rich flushes M10 *Carex dioica-Pinguicula vulgaris* mire on the north and east side. The southern end has a mix of wet heath and blanket bog M15/M17 with M19 *Calluna vulgaris-Eriophorum vaginatum* blanket mire becoming prominent on the north and west margins of the loch on deeper peat on sloping ground. A little peat is exposed here but it is nowhere extensive on the west side.

Table 27 Macrophyte Species List

Transcect	Waterbody	Start Transect Coordinates		End Transect Coordinates		Submerged / Floating	DAFOR	Emergent / Edge	DAFOR	Dominant Substrate Type
		Easting	Northing	Easting	Northing					
T1	Loch Earba East	248851	784141	248854	784044	*Littorella uniflora*	A	*Equisetum fluviatile*	R	Stones, Gravel, Sand, Silt, Peat
						Callitreien bretia	A			
						Isoetes lacustris	A			
T2	Loch Earba East	249000	783932	248925	783080	*Littorella uniflora*	F	*Carex rostrata*	A	Stones, Gravel, Sand, Silt, Peat
						Lobelia dortmanna	F			
						Myriophyllum alterniflorum	A	*Equisetum fluviatile*	O	
						Potamogeton natans	A			
						Utricularia minor	R	*Littorella uniflora*	O	
						Potamogeton polygonifolius	O			
T3	Loch Earba East	250011	785628	249945	785571	*Littorella uniflora*	F	*Carex rostrata*	F	Boulders, Stones, Gravel, Peat
						Myriophyllum alterniflorum	F	*Equisetum fluviatile*	F	
						Juncus Bufonius	A	*Littorella uniflora*	F	
						Callitreiche brutia	A	*Schoenoplectus lacustris*	O	
								Isolepis setacea	A	
T4	Loch Earba East	250110	785579	250055	785531	*Myriophyllum alterniflorum*	F	*Carex rostrata*	F	Boulders, Stones, Gravel, Peat
								Littorella uniflora	O	
						Potamogeton natans	R	*Ranunculus flammula*	O	
								Molinia caerulea	A	

Transect	Waterbody	Start Transect Coordinates		End Transect Coordinates		Submerged / Floating	DAFOR	Emergent / Edge	DAFOR	Dominant Substrate Type
		Easting	Northing	Easting	Northing					
						Littorella uniflora	O	*Carex panicea*	A	
								Galium palustre	F	
						Utricularia sp.	O	*Chara sp.*	F	
								Equisetum fluviatile	R	
						Chara sp.	O	*Glyceria fluitans*	O	
						Potamogeton polygonifolius	O	*Juncus articulatus*	O	
								Juncus bulbosus	O	
T5	Loch Leamhain	250148	779734	250213	779693	*Littorella uniflora*	R	*Littorella uniflora*	R	Boulders, Stones, Gravel, Sand Silt, Peat
						Isolepis setacea	F	*Juncus bufonius*	R	
						Callitriche brutia	O			
T6	Loch Earba West	246395	781491	246623	781167			*Equisetum fluviatile*	R	Sand dominated
								Juncus bulbosus	F	
								Ranunculus fluitans	O	
								Carex rostrata	O	
								Viola palustris	O	
								Carex pseudocyperus	R	
								Myrica gale	O	
								Carex riparia	O	

Transcect	Waterbody	Start Transect Coordinates		End Transect Coordinates		Submerged / Floating	DAFOR	Emergent / Edge	DAFOR	Dominant Substrate Type
		Easting	Northing	Easting	Northing					
								Equisetum arvense	R	
T7	Loch Earba West	248318	783233	248348	783240	*Potamogeton polygonifolius*	F	*Juncus bulbosus*	F	Boulders within marginal areas with Sand/Silt/Gravel where macrophytes were located
								Juncus bufonius	F	
								Ranunculus flammula	F	
								Viola palustris	O	
								Carex panicea	F	
								Carex nigra	F	
T8 & T9	Loch Earba West	248297	783464	248206	783453	*Potamogeton polygonifolius*	F	*Lobelia dortmanna*	F	Boulder, Sand, Peat Wet heath creeping into shoreline area
								Juncus bufonius	F	
								Carex panicea	F	
								Carex nigra	F	
								Ranunculus flammula	F	
								Salix repens	R	
								Juncus articulatus	O	
								Eriophorum angustifolium	O	

4 Discussion

4.1 Macroinvertebrates

Macroinvertebrate results in Loch Earba East and adjoining tributaries (MS1, MS2 and MS6) displayed high variation in BMWP, CCI, PSI(TL5) and EPSI(TL5) values throughout Spring sampling. Both MS1 and MS2 were indicative of high water quality with high BMWP (118 and 82), PSI (77.27 and 95.00) and EPSI (89.78 and 100.00). MS02 displayed high BMWP, PSI and EPSI scores, however, the CCI score was considerably lower. Summer sampling was also indicative of variation scoring highly on BMWP (73 and 125) and EPSI (89.87 and 94.79) indices.

MS06 displayed lower values on all biotic indices in Spring: BMWP (37); PSI (37.50); EPSI (63.13); and CCI (8.40) and in Summer: BMWP (25); PSI (28.57); and CCI (1.5) with the exception of EPSI (100). The watercourse sampled for MS06 was noted to periodically dry out with limited compensation flow during summer months, resultingly the watercourse is unlikely to host species indicative of high water quality such is seen in MS01 and MS02.

Macroinvertebrate results in Loch Earba West (MS3 and MS4) similarly displayed variation between survey points. MS03 scored high BMWP (75), PSI (100), EPSI (100) but low on CCI (6.00). Similarly MS04 scored low BMWP (22) but high PSI (100), EPSI (83.33) and very high CCI (17.5), the highest CCI observed. Little variation was observed between Spring and Summer sampling.

Macroinvertebrate results in Loch Leamhain (MS7, MS8 and MS10) varied between Spring and Summer sampling. MS7 scored moderately on BMWP, PSI and EPSI but indicated Fairly high conservation value on the CCI index throughout both Spring and Summer sampling. MS8 indicated very high BMWP (122), PSI (95.24), EPSI (95.42) and CCI (14.00). The presence of the Arctic-alpine pea mussel (*Euglesa conventus*) was identified within this site[6]. The Arctic-alpine pea mussel is considered rare and limited in UK distribution to one site in Wales and several in the Scottish highlands. Presence in Loch Leamhain is characteristic of cold water at high elevations, however, presence within watercourses is not typical of the species (Moorkens and Killeen, 2009).

MS10 indicated high BMWP (80), PSI (93.33) and EPSI (97.29). CCI values were extremely high, and the only Survey Location recorded to have a Very high conservation status, that was in considerable excess of >20 at 25.45. This is due to the presence of Davis's river diver (*Oreodytes davisii*) and the presence of oligotrophic lentic specialists (*Oligotrophic striata* and *Apatania wallengreni*). Overall, Loch Leamhain indicated macroinvertebrates of higher conservation value both in the Loch itself and the outflow.

Macroinvertebrates observed are categorised by a diverse range of environmental tolerances and preferences, consequently communities are likely to exhibit both qualitative and quantitative responses to the range of environmental changes (for example: water depth; water temperature; water quality changes) (Sykes *et al.,* 1999).

Increasing the water level of both Loch Earba and Loch Leamhain is additionally likely to alter the profiles of both shorelines. Existing marginal habitat is dominated by shallow shelfs and/or gently sloping margins, this is predicted to become steeper in light of water level changes reducing the area of suitable habitat and therefore the diversity within these areas. Re-profiling or changes to marginal areas is considered damaging to invertebrates (Buglife, 2023). Due to this change, and increased rates of water level changes in drawdown zones, benthic communities are likely to shift to a dominance of mobile groups, e.g. beetles and

[6] Species was externally verified by Dr. Ben Rowson, National Museum Wales

water boatmen, that are able to track water levels or profundal communities better adapted to predicted future conditions.

Macroinvertebrates are reliant on established macrophyte communities in marginal areas, for changes in macrophyte communities see Section 4.7.

4.2 Water Quality

Within Visit 1 Temperature ranged from 8.7°C (WQ12) to 11.3°C (WQ01), with an average of 10.18°C and from 7.1°C (WQ) to 11.9°C (WQ), with an average of 9.65°C within Visit 2. All values are within the optimal range of 6-20°C, however, no values were within the range of 16-17°C where maximal growth occurs in salmonids (Fisheries Management Scotland, 2023). This is not unexpected given the elevation of the drainage basin contributed colder water on average.

The pH ranged from 6.2 (WQ05) to 7.9 (WQ12) (average of 6.89) during Visit 1 and from 6.1 (WQ) to 7.8 (WQ) (average of 6.78). Optimal ranges for salmonids is pH 6.5 - 8.0 (Staurnes *et al.,* 1995). A large number of observed water quality Survey Locations fell outwith this threshold including WQ2, WQ4, WQ5, WQ6, WQ7, WQ11, however, the maximum deviance from optimal ranges was pH 0.4 below pH 6.5. No Survey Locations exceeded alkalinity limits. The pH Loch Earba East (6.6-6.3) and Loch Earba West (6.3-6.1) are consistent with oligotrophic status that is typically less than 7. The pH within Loch Leamhain exceeded this by 0.5 at pH 7.5.

Electrical Conductivity (µS/cm) ranged from 20 µS/cm to 52 µS/cm (average of 32.5 µS/cm) during Visit 1 and ranged from 14 µS/cm (WQ) to 31 µS/cm (WQ) (average of 20.7 µS/cm) during Visit 2. All conductivity values observed are considered low and indicative of minimal pollution sources.

Total Dissolved Solids (TDS) (mg/l) ranged from 13 mg/l to 35 mg/l (average of 20.92 mg/l) during Visit 1 and ranged from 9 mg/l (WQ) to 18 mg/l (WQ) (average of 13.10 mg/l) during Visit 2. All TDS values are low and indicative of minimal pollution sources within the watercourses/waterbodies sampled, this is reflective of low conductivity. Salmonids are sensitive to high TDS values (e.g. >250 mg/L may reduce fertilisation), however, values observed are considerably lower (Stekoll *et al.,* 2003).

Dissolved Oxygen (DO as %) ranged from 89.6% to 110% (average of 105.5%) and ranged from 100% (WQ) to 104.5% (WQ) (average of 102.85%). Dissolved oxygen (DO as mg/l) ranged from 9.8 mg/l to 12.5 mg/l (average of 11.56 mg/l) and ranged from 10.1 mg/l (WQ) to 911.4 mg/l (WQ) (average of 10.79 mg/l). All values of dissolved oxygen fell within assessment criteria, 8-15 mg/L and were considerably higher than hypoxic levels, <6 mg/L (Alver *et al.,* 2022).

Oxidative Reduction Potential (ORP) (millivolts (mV)) ranged from 109.6 mV to 163.7 mV (average of 134.82 mV) and ranged from 108.9 mV (WQ) to 179.4 mV (WQ) (average of 148.35 mV). No thresholds relevant to salmonids or other species present is currently available.

4.3 Fish Habitat

The habitat quality at each Survey Location was variable for supporting salmonid populations (as dictated by SEPA methodology). Survey locations varied in the occurrence of Productive (high), Productive (moderate), Productive (low), Lamprey and Not Suitable habitat; no bedrock channels were present.

Productive habitat displayed high variation from Productive (high) to Productive (low).

Productive (high) habitats were not widely present throughout the areas surveyed primarily due to a lack of instream and bankside cover, and the presence of impassable obstacles. All Productive (high) habitat was located on the Moy Burn and the river connecting Loch Earba East and West. The Moy burn displayed good instream cover, riffle/run flow sequences, a lack of obstacles to fish movement and patches of optimal spawning substrate (well-washed gravel/pebble stretches). The connective river was categorised for the presence of riffle/run flow sequences, instream and bankside vegetation, a large section of optimal substrate was additionally identified.

Productive (moderate) was the predominant habitat type covering 69.65% of the area surveyed. All watercourses surveyed at Loch Leamhain were categorised as Productive (moderate), watercourses were limited by steep altitudes of the tributary and a lack of bankside cover.

Productive (low) habitats were primarily situated in lower lying catchments and on the loch margins where tributaries meet waterbodies. Such habitats were characterised by high percentages of silt and fine sediments, no instream/bankside cover, little/no water flow and visibly turbid/stained water.

No Bedrock Channel habitat was identified on the watercourse surveyed. Several stretches of watercourse, notably the Allt Coire Pitridh, contained a high percentage of boulder within the substrate however this wasn't present as channels and provided some instream cover.

Not suitable habitat detailed habitat that had no potential to support salmonid populations. Two unnamed tributaries in Loch Earba West were dry at the time of survey (indicated by Not Suitable Habitat) and displayed limited substrate presence. As habitat quality was assessed at the time of survey they displayed no potential to support salmonid populations. Such watercourses are likely seasonal drainage channels and not established watercourses, and therefore may have water during high rainfall periods.

Despite this presence of Lamprey Habitat, Lamprey are unlikely to be present within any waterbodies and watercourses surveyed due to the presence of existing obstacles both downstream in the catchment and within the red line boundary; 'Lamprey Habitat' thus details the presence of silted areas suitable for lamprey and is not indicative of presence.

Loch margin substrate, including rocky substrate and sand, is consistent with oligotrophic status of Loch Earba West and East, and Loch Leamhain.

4.3.1 Loch Spawning Habitat Assessment

Transect Data 15m

Of the 713m of transect surveyed, 477m (67%) was classified as 'poor', 82m (12%) was classified as 'sub-optimal' and 154m (21%) was classified as 'optimal' for spawning habitat based on the information collected at the time of survey.

It is important to note that loch levels were high at the time of survey and some areas recorded as 'optimal' may become unviable for spawning when loch levels drop due the levels on both loch basins being altered by the existing hydroscheme. When overlaying the field data against the mapped extent of the lochs at their lowest allowable water levels this was more apparent. Aerial mapping (Bing Mapping) shows evidence of the loch at a much lower level versus the time of survey (**See Appendix E - Figures 2.1-2.4)**. Using the lowest allowable water level shapefile as a basis, the habitat would have been classified differently, i.e. only 45m (6.4%) classified as 'optimal' for spawning habitat due to the availability of less wetted area. While the lowest allowable water level is not encountered every year, anecdotal evidence suggests it is not uncommon. Therefore, the spawning habitat assessment secondary analysis indicates the likely spawning habitat availability under reasonable worst case conditions.

Point Location Data (50m Spot Checks)

Of the 120 point locations surveyed, 117 (97.5%) were classified as 'poor', 2 (1.67%) were classified as 'sub-optimal' and 1 point (0.83%) was classified as 'optimal'.

The depths of point locations surveyed ranged from 0.4 - 24.4m with an average depth of 11.4m. Point locations were typically at least 50m out from the water's edge and extended across the loch giving a good coverage of a range of depths in combination with the 15m transects. The only optimal rated point location actually fell just outside 15m from the water's edge and at a depth of 1.5m. Any of the points beyond 15m from the water's edge predominantly featured 'poor' habitat.

Due to the very limited 'optimal' / 'sub-optimal' spawning habitat recorded at point locations, with the habitat predominantly 'poor', it is very unlikely that Arctic charr are utilising deeper areas for spawning within the Loch Earba basins.

For full details of the Loch Spawning Habitat Assessment, please refer to **Appendix E**.

4.4 Fish Population (Electrofishing)

4.4.1 2023 Electrofishing Surveys

In total, two fish species were definitively identified during 2023 electrofishing surveys: brown trout and Eurasian minnow. A further species, Arctic charr, was tentatively identified at this time.

Brown trout showed the greatest distribution within the survey areas and was present on all watercourses where fish were detected. Eurasian minnows were similarly present on 5 out of 6 electrofishing Survey Locations where fish were detected. Suspected Arctic charr were detected within three Survey Locations. Similarities in Brown trout and Arctic charr during their fry life stage that inhibited accurate identification to species level in the field. A selection of three photographs were sent for external verification and it was indicated these fish could be Arctic charr but without certainty due to the difficulties in distinguishing brown trout from Arctic charr (<50mm) at the fry stage.

Presence of Arctic charr in streams would not be unexpected given juveniles have been readily recorded utilising streams as nursery areas in Scotland (Maitland *et al.*, 1984). As no adults were recorded during electrofishing surveys, the possible presence of juvenile charr would suggest that if present, some adult Arctic charr utilise streams for spawning and drop back into the deeper water of standing waterbodies or juveniles actively move into streams as fry. If present, the presence of river spawning Arctic charr would increase their conservation value due to limited identified occurrences in Scotland (10 recorded instances with several having since gone extinct) (Walker, 2007).

Population density and average fish size displayed a weak inverse relationship with the sites of highest population density supporting the smallest average fish size. Survey Location EA6 displayed a population density of 0.08 fish per m^2 and the second highest average size at 63.20 mm. Survey Location EA4 displaying a population density of 0.12 fish per m^2 and displayed the largest average size at 84.30 mm.

Although presence of Arctic charr were not identified in Loch Earba West during gillnetting, the possible presence of juveniles and absence of adults indicates that if present, they may reside in the Loch. As numbers in Loch Earba West were undetectable via gillnetting, the population, if present, is considered to be in unfavourable condition status.

Survey Locations where no fish species were identified (EA7-EA9) did not provide high quality habitat. Both EA7 and EA8 were located on the loch margins, this provided poor fish habitat quality in the ecologically depleted zone.

All fish populations are considered natural and self-sustaining; there were no records of stocking identified during the desk study.

4.4.2 2024 Electrofishing Surveys

For full details of the 2024 Electrofishing surveys see **Appendix F.**

In total, two fish species were identified during the 2024 electrofishing surveys: Brown trout and Eurasian minnow.

Brown trout showed the greatest distribution within the survey areas and were present in all of the watercourses surveyed. Eurasian minnow were similarly present in three of the five electrofishing survey locations. No Arctic charr were detected within the Survey Locations at the time of survey.

Brown trout fry (0+) were present at survey locations EA1 – EA6. Brown trout parr (1++) were present at survey locations (EA2, EA3, EA5 and EA6) but absent from EA1, possibly due to a lack of bankside cover and large substrate which provides instream cover for larger fish.

Fully quantitative population estimates for brown trout fry (0+) ranged from 6.1 per 100m^2 (EA3) to 58 per 100m^2 (EA5). For brown trout parr (1++), most densities captured were low therefore some of the results could not be applied to the statistical depletion model (EA1, EA3 & EA5). These densities are expressed as a minimum estimate. Fully quantitative density estimates for brown trout parr ranged from 4.2 per 100 m^2 (EA2) – 8.3 per 100 m^2 (EA6). Including minimum density estimates, densities ranged from absent (EA1) to 8.3 per 100 m^2 (EA6).

No Arctic charr were detected in the 2024 electrofishing surveys. It is possible that in 2023 Arctic charr thought to have been detected could have been juveniles using burns as nursery areas (Maitland *et al.*, 1984) and this recruitment did not take place during the following spawning season. Another explanation for an absence of Arctic charr in 2024 may be that the juveniles had already migrated downstream to Loch Earba before the time that the electrofishing survey had taken place. This may also explain why there were no 1++ juvenile charr / adult charr present at the survey locations. This represents a limitation to the population survey and is a trade off against juvenile fry being of suitable size to identify to species level. It was previously agreed with SEPA that the population survey should take place later on in the survey season (mid to late August) to allow for easier identification of fry to species level.

Furthermore, there is a recognised difficulty in accurately speciating fish fry specimen in individuals which are <50 mm in length. While every professional effort has been made to accurately speciate all individual fish captured (including the use of expert external verification), there remains a possibility that individual fish specimen may have been mis-identified (either during the 2023 or 2024 survey results).

4.5 Fish Population (Gillnetting)

Trout in Loch Earba East showed the highest range in fork length with individuals ranging from 105 mm to 500 mm (range of 395 mm) compared to Loch Earba West that ranged from 80 mm to 300 mm (range of 220 mm). Disparities in fork length are largely due to the presence of one large trout in Loch Earba East (500 mm) that significantly increased the range; this was the largest fish identified throughout all surveys.

Within Loch Earba East, pelagic gillnets set in deep water (21 m) caught the largest number of fish at 9 and 25 individuals over both net nights. Benthic gillnets set in shallow (8 m) water similarly caught a large proportion of the total fish caught at 8 and 17 individuals over both net nets. Benthic gillnets in deep water caught the least number of fish at 1 and 4 individuals over both net nights. The second net night caught 4 fish, all Arctic charr, representing the total Arctic charr caught with gillnetting effort.

Similarly in Loch Earba West, pelagic gillnets set in deep water (20 – 20.5 m) and benthic gillnets in shallow water (8 m) represented a significant proportion of the total catch at 25 and 20 individuals, and 10 and 26 individuals respectively over both net nights.

Although present in large numbers within pelagic habitats, results are indicative of habitat use during crepuscular and nocturnal periods and thus may be a result of diurnal vertical diurnal migration. Consequently, fish may only be present in pelagic environments during this period. Fish have also been identified as showing seasonal changes in habitat use associated with reproduction and during summer where changes in solar radiation, flow and water temperature may influence prey availability (Garcia-Vega *et al.*, 2017).

Overall, gill netting results suggest a wide use of depths and zones of water usage from brown trout throughout all areas of both waterbodies.

4.6 eDNA

The 2023 eDNA survey targeted Loch Leamhain only with the objective indicating the presence or absence of Arctic charr specifically. Sampling was undertaken in accordance with the prevailing method at the time. No positive match for the presence of Arctic charr was detected when compared against a known reference Arctic charr DNA profile from another Scottish loch. While no presence was detected, it was considered that the DNA signature was below the limit of detection based on the volume and quantity of sample media collected. As a result, the 2023 eDNA survey were considered to be inconclusive. As a result, it was considered that further eDNA survey work was required.

As a result, a more comprehensive and robust programme of eDNA sampling was undertaken during 2024. For full details of the 2024 eDNA surveys, refer to the Preliminary Presentation in Appendix G . The 2024 survey method and analytical technique was informed and supervised by eDNA specialists from UHI's Institute for Biodiversity and Freshwater Conservation. The 2024 survey included samples from all three lochs, and used an alternative eDNA analysis technique which identified all fish species present. The 2024 eDNA survey confirmed the presence of Brown trout in all three lochs, and the presence of Eurasian minnow in both Loch Earba basins. However, it also indicated the absence of Arctic charr in both Loch Leamhain and Loch Earba West. A small positive detection for Arctic charr was detected in Loch Earba East, however the implied population appears to be small based on the very small proportion of Arctic charr eDNA detected (relative to Brown trout and Eurasian minnow), and the spatially disparate nature of the Arctic charr detections when compared with the ubiquity of the other two species detected.

UHI's analysis of the relative proportion of each fish species' presence within the total eDNA reads for fish DNA indicates that Brown trout comprise 100% of the fish DNA detected within Loch Leamhain. Within Loch Earba West, Brown trout and Eurasian minnow were detected in approximately equal proportion. Within Loch Earba East, Brown trout DNA reads were found to outnumber Eurasian minnow DNA by a factor of approximately 3:1. While DNA counts do not equate directly to population size, it does provide an indication of relative population abundance of each species in a given location. Arctic charr DNA comprised a trace proportion (0.41% of total eDNA counts) of the overall fish DNA detected within Loch Earba East. This result may indicate that the Arctic charr population present in Loch Earba East is likely to be very small relative to the numbers of Brown trout and Eurasian minnow present.

The 2024 eDNA results appear to contradict the findings of the 2023 electro fishing surveys in the burns feeding from Loch Leamhain, and into Loch Earba where suspected Arctic charr fry were identified. There are a number of potential explanations for these results. As noted above, there are significant difficulties in visually identifying fish to species level during the earliest stages of their lifecycle. As a result, it is possible that those specimens tentatively identified as Arctic charr in 2023 may have been misidentified. Given the surveys undertaken, and the timing of those surveys, it is possible that small numbers were present in the burns during the electrofishing survey, but that the overall population is so small as to be undetectable using eDNA techniques.

When the respective strengths of the different survey techniques are considered, it is believed that the 2024 eDNA survey results are the strongest individual line of evidence on the current fish populations in each of the three lochs. The electrofishing and gillnetting used generate 'fish in hand' which gives good confidence on the species present (and other factors, such as polymorphism) (except on the smallest specimens, as noted) however they are by practical necessity selective techniques which reveal a small sub-set of the population present at the time of the survey. By contrast, the eDNA technique doesn't produce physical fish samples for further analysis (or visual/photographic evidence), however it does provide better information on the 'whole' population present at a given time as the eDNA signature for each species should be detectable even if individual fish numbers are small, or the fish have recently migrated away from the location directly sampled.

On balance, it is considered that the 2024 eDNA provides the most authoritative evidence for current fish populations present within the Proposed Development area. From this it can be concluded that Arctic charr are present in Loch Earba East, albeit in probably small numbers. Similarly, it can be concluded that Arctic charr are functionally absent from both Loch Earba West and Loch Leamhain, or present in such small numbers as to be undetectable using eDNA.

4.7 Macrophytes

In total 37 species were identified in the three waterbodies surveyed.

All transects undertaken indicated species with little conservation, designated as 'Least Concern' (Botanical Society of Britain & Ireland, 2023).

Submergent communities displayed smaller species variation, when compared to emergent communities, with 17 species identified. There was a wide disparity in submergent species presence and abundance between Loch Earba East and, Loch Leamhain and Loch Earba West. Loch Earba East identified 18 species whereas Loch Leamhain and Loch Earba West identified 3 and 1 respectively. Submergent macrophyte communities are critical for maintaining sediment stability on loch margins. Any loss of species diversity and abundance as a result of the proposed development may contribute deterioration and erosion of marginal substrate with consequent effects on water quality (Salgado *et al.,* 2010).

Emergent communities contributed 22 species. Each transect displayed greater species count when compared to submergent communities, however, similar species were identified within each transect. Loch Earba West showed highest species variation with 18 identified followed by 12 in Loch Earba East; Loch Leamhain was significantly lower at 2 species present. Overall low macrophyte diversity and abundance is consistent with nutrient poor oligotrophic status Lochs (Smith, Maitland and Pennock, 1987).

Of species identified within Loch Earba East the majority displayed relatively high abundance on the DAFOR scale with the majority of species being recorded as 'Frequent', 'Abundant' or 'Occasional'. Three species were categorised as 'Rare', one emergent (*Equisetum fluviatile*) and two submerged (*Potamogeton natans, Utricularia minor*). Loch Earba West recorded most species as 'Abundant' or 'Occasional' with four species recorded as 'Rare' (*Equisetum fluviatile, Carex pseudocyperus, Equisetum arvense, Salix repens*). Loch Leamhain was considerably lower in both species presence and abundance with 2 species recorded as 'Rare' in abundance (*Littorella uniflora, Juncus bufonius*). No species were recorded to be in 'Dominant' abundance.

Discrepancies between emergent and submergent species present, and their abundance, throughout loch surveyed are likely explained by the differences in environmental conditions. Loch Leamhain likely experiences colder average temperatures due to increased elevation (600 m AOD vs 350 m AOD) and can thus only support macrophytes with greater temperature resistance. Limited species present in Loch Leamhain are consistent with those in the nearest Loch of similar altitude and size, Loch Pattack, that recorded a dominance of *Juncus bulbolus* and *Littorella uniflora* (Hardin and Day, 1995).

Studies of upper lochs utilised for Pump Storage Hydro (e.g. Cruachan Reservoir) have displayed negligible or reduced macrophyte communities during operational period (no baseline surveys available) (Smith, Maitland and Pennock, 1987). The frequency at which maximum and minimum water levels are reached is not established, however, water level is predicted to vary by 70 m (640 m AOD to 710 m AOD) during operation. Such extreme changes in environmental conditions including light, temperature and nutrient availability are likely to reduce macrophyte community assemblages resulting in a less diverse and abundant macrophyte community. This is likely to reduce macroinvertebrate diversity and abundance in marginal zones (Beckett *et al.,* 1992).

Current impoundments on Loch Earba East and West display water level changes of several metres. Thus, the waterbodies likely have an existing effect of water level change. Due to a lack of baseline macrophyte data preceding historical development, any effect of current impoundments cannot be concluded (as current macrophyte communities may represent original communities or decreased coverage), however, comparisons with other nutrient poor oligotrophic lochs suggest minimal effect is likely to occur due to reduce baseline abundance/diversity (Smith, Maitland and Pennock, 1987). Similarly to Loch Leamhain (upper loch) extreme changes in environmental conditions are likely to reduce macrophyte community assemblages in both abundance and diversity. The majority of species identified, e.g. emergent *Juncus bulbosus,* are tolerant of moderate water level changes but are absent if fluctuations are large.

No invasive non-native species (INNS) were identified in the three waterbodies surveyed. The presence of *Rhododendron ponticum* was identified in terrestrial habitats on the loch margins. Therefore, there is no risk of the proposed development facilitating the transfer of INNS between the three lochs surveyed, and waterbodies further down the catchment (e.g. Loch Laggan and Loch Pattack).

Species identified including: *Potamogeton polygonifolius*, *Juncus bulbosus*, *Lobelia dortmanna* and *Isoetes lacustri* support the characterisation of oligotrophic status in Loch Earba West and East, and Loch Leamhain.

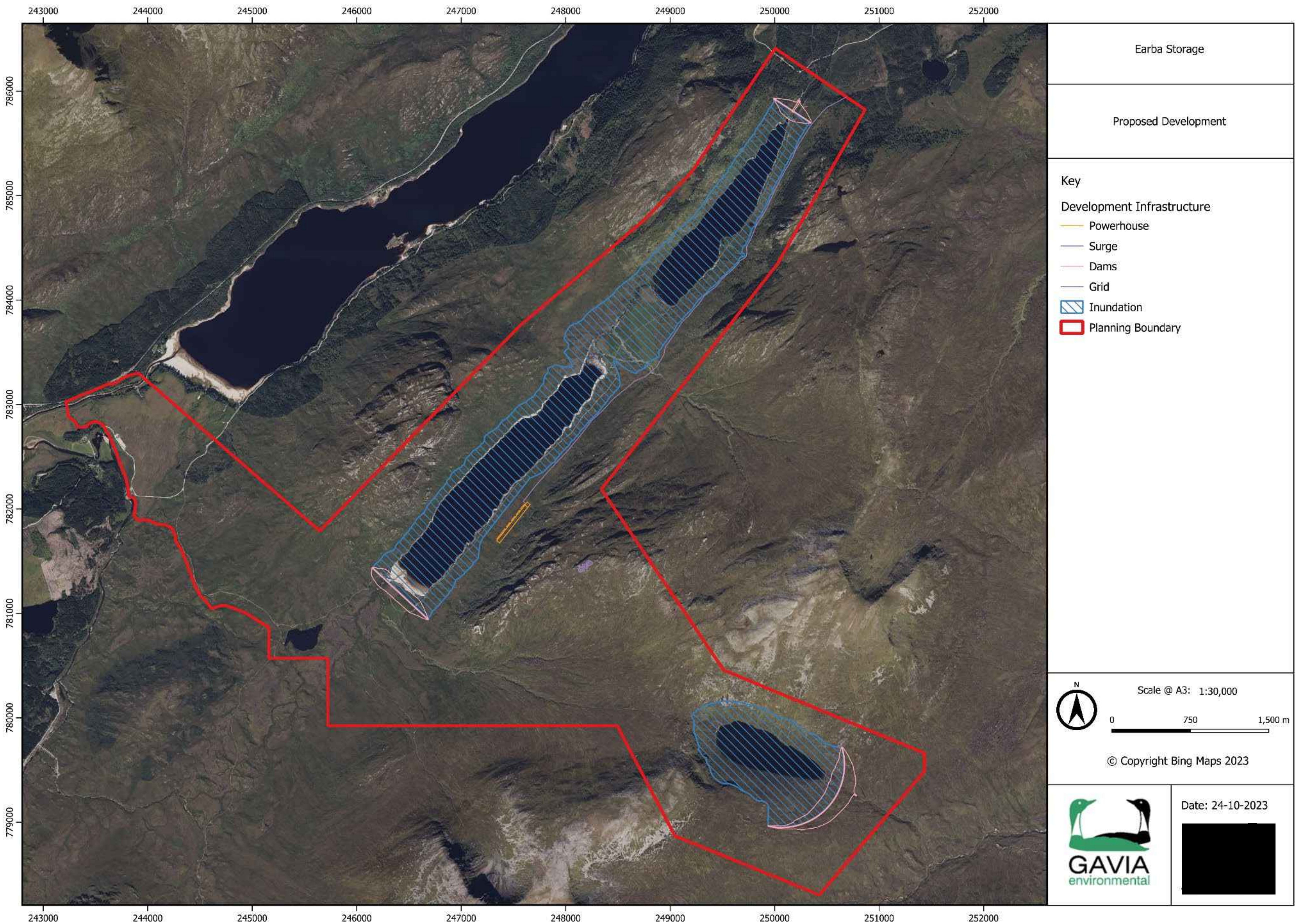
5 [redacted]

[redacted]

[redacted]

6 Appendices

Appendix A Maps


Earba Storage
Proposed Development
Key
Development Infrastructure
Powerhouse
Surge
Dams
Grid
Inundation
Planning Boundary
N
Scale @ A3: 1:30,000
0
750
1,500 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 24-10-2023
[redacted]
243000
244000
245000
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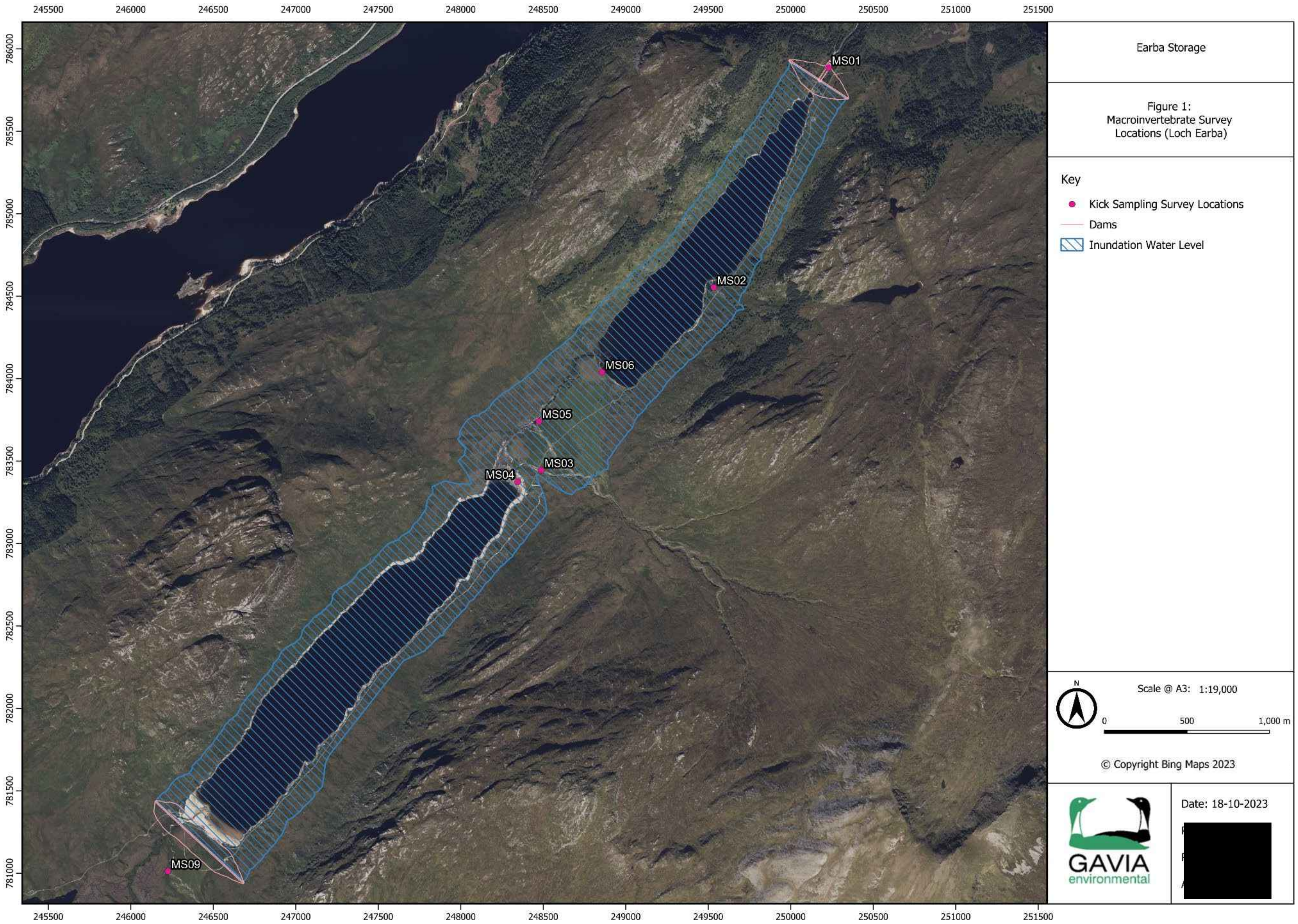
Earba Storage
Figure 1:
Macroinvertebrate Survey
Locations (Loch Earba)
Key
Kick Sampling Survey Locations
Dams
Inundation Water Level
MS01
MS02
MS03
MS04
MS05
MS06
MS09
245500
246000
246500
247000
247500
248000
248500
249000
249500
250000
250500
251000
251500
786000
785500
785000
784500
784000
783500
783000
782500
782000
781500
781000
N
Scale @ A3: 1:19,000
0
500
1,000 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 18-10-2023
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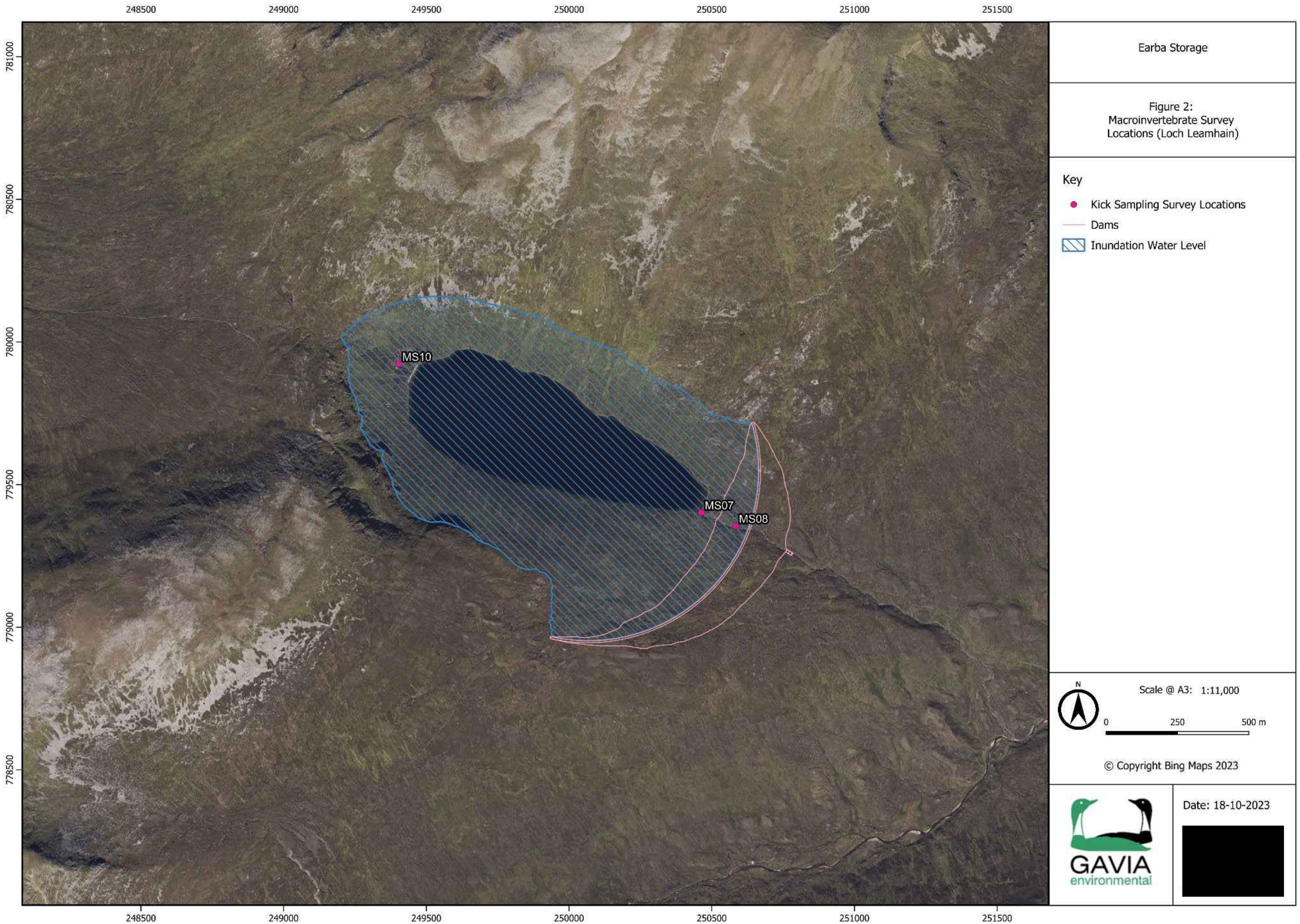
Earba Storage
Figure 2:
Macroinvertebrate Survey
Locations (Loch Leamhain)
Key
Kick Sampling Survey Locations
Dams
Inundation Water Level
MS10
MS07
MS08
248500
249000
249500
250000
250500
251000
251500
781000
780500
780000
779500
779000
778500
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0
250
500 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 18-10-2023
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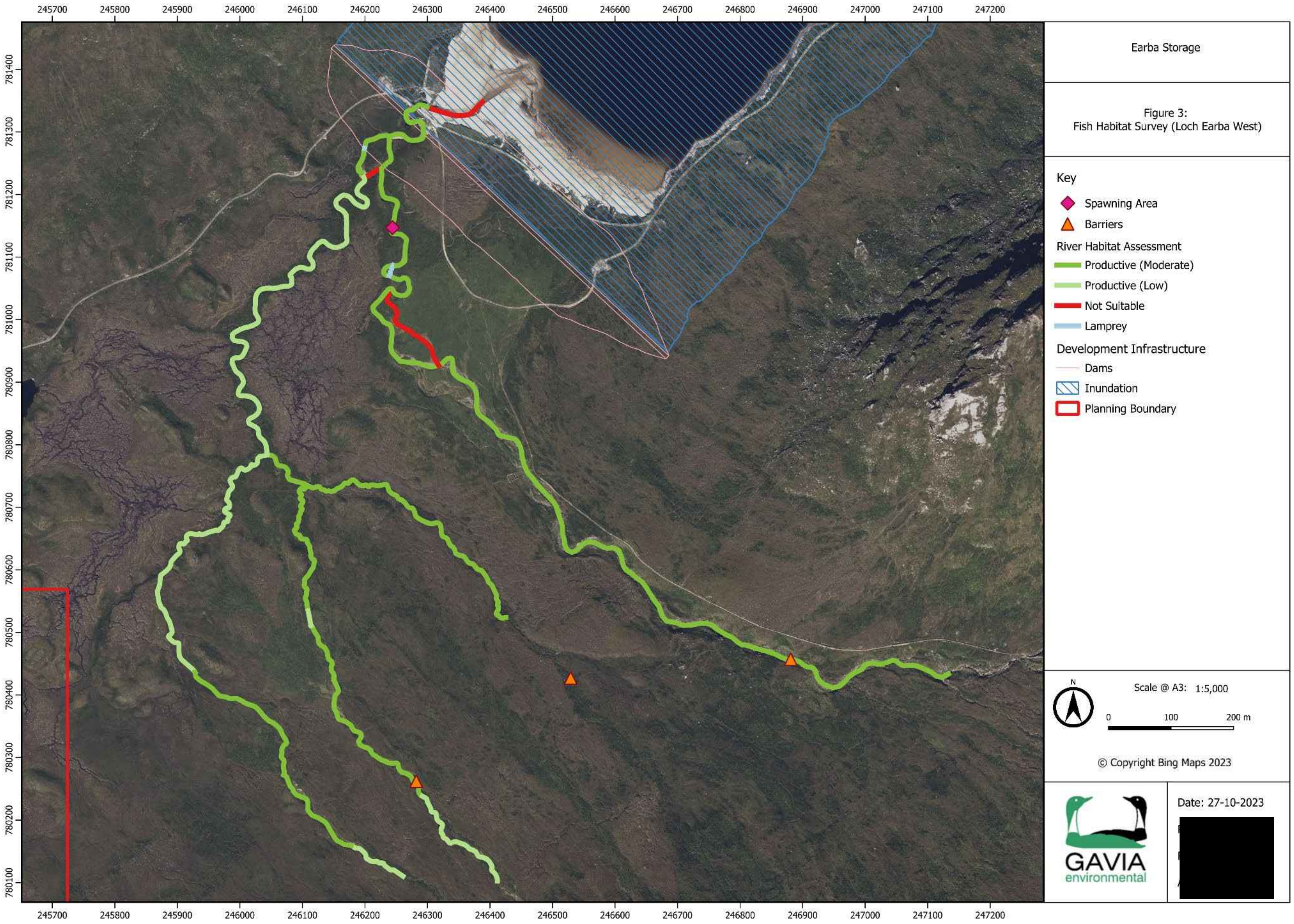
Earba Storage
Figure 3:
Fish Habitat Survey (Loch Earba West)
Key
Spawning Area
Barriers
River Habitat Assessment
Productive (Moderate)
Productive (Low)
Not Suitable
Lamprey
Development Infrastructure
Dams
Inundation
Planning Boundary
N
Scale @ A3: 1:5,000
0
100
200 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 27-10-2023
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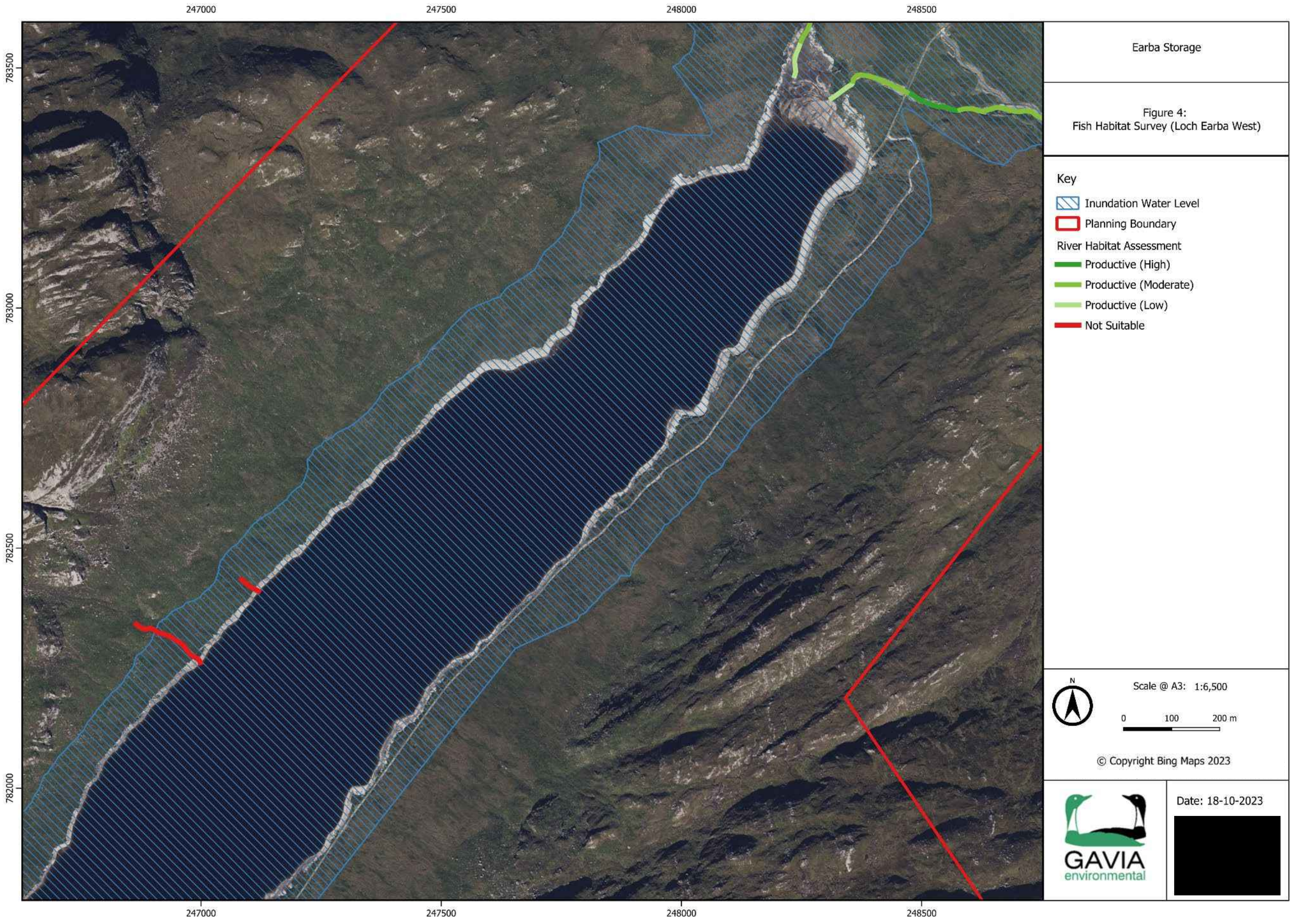
247000
247500
248000
248500
783500
783000
782500
782000
Earba Storage
Figure 4:
Fish Habitat Survey (Loch Earba West)
Key
Inundation Water Level
Planning Boundary
River Habitat Assessment
Productive (High)
Productive (Moderate)
Productive (Low)
Not Suitable
N
Scale @ A3: 1:6,500
0 100 200 m
© Copyright Bing Maps 2023
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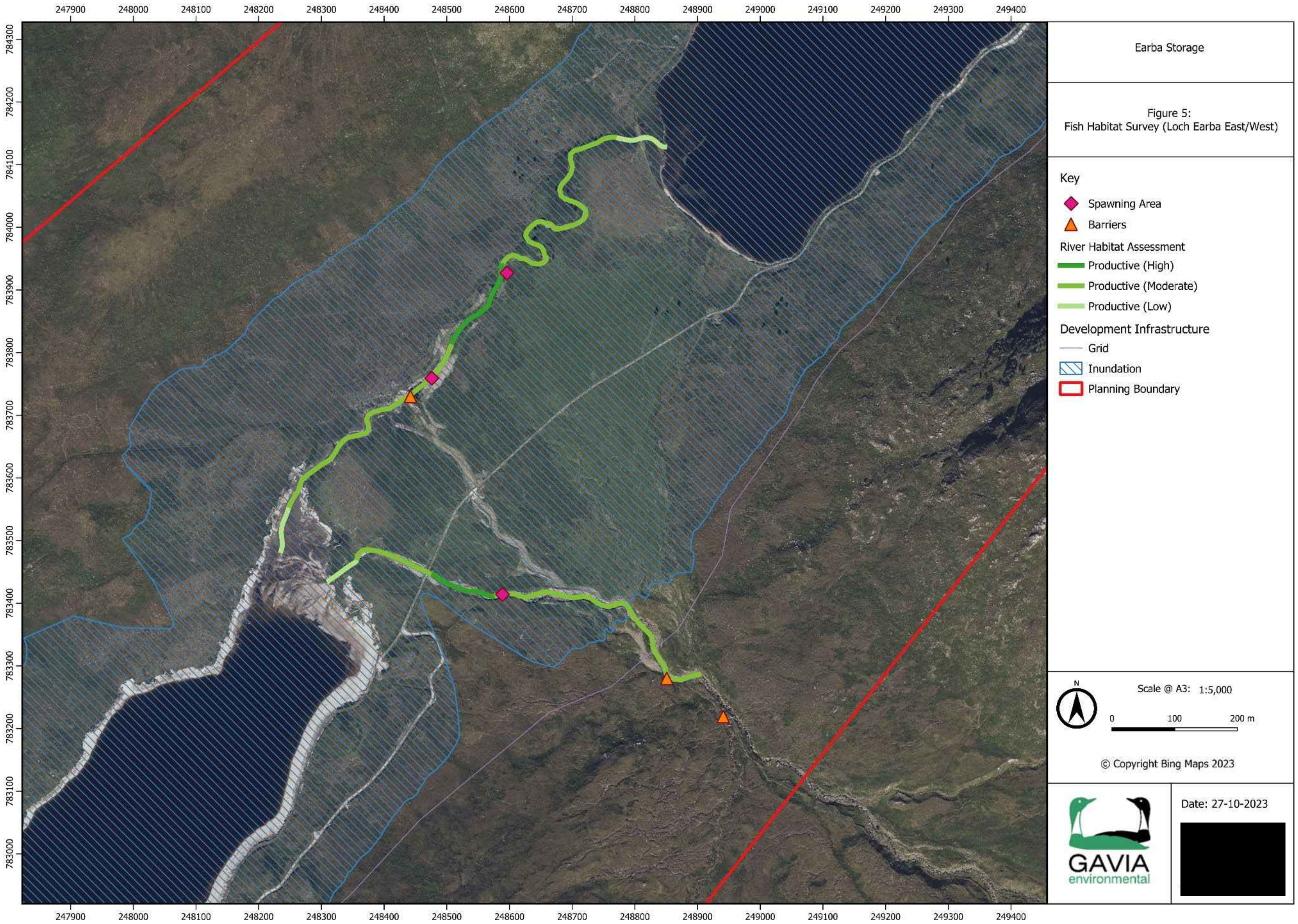
environmental
Date: 18-10-2023
[redacted]


Earba Storage
Figure 5:
Fish Habitat Survey (Loch Earba East/West)
Key
Spawning Area
Barriers
River Habitat Assessment
Productive (High)
Productive (Moderate)
Productive (Low)
Development Infrastructure
Grid
Inundation
Planning Boundary
Scale @ A3: 1:5,000
0 100 200 m
© Copyright Bing Maps 2023
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environmental
Date: 27-10-2023
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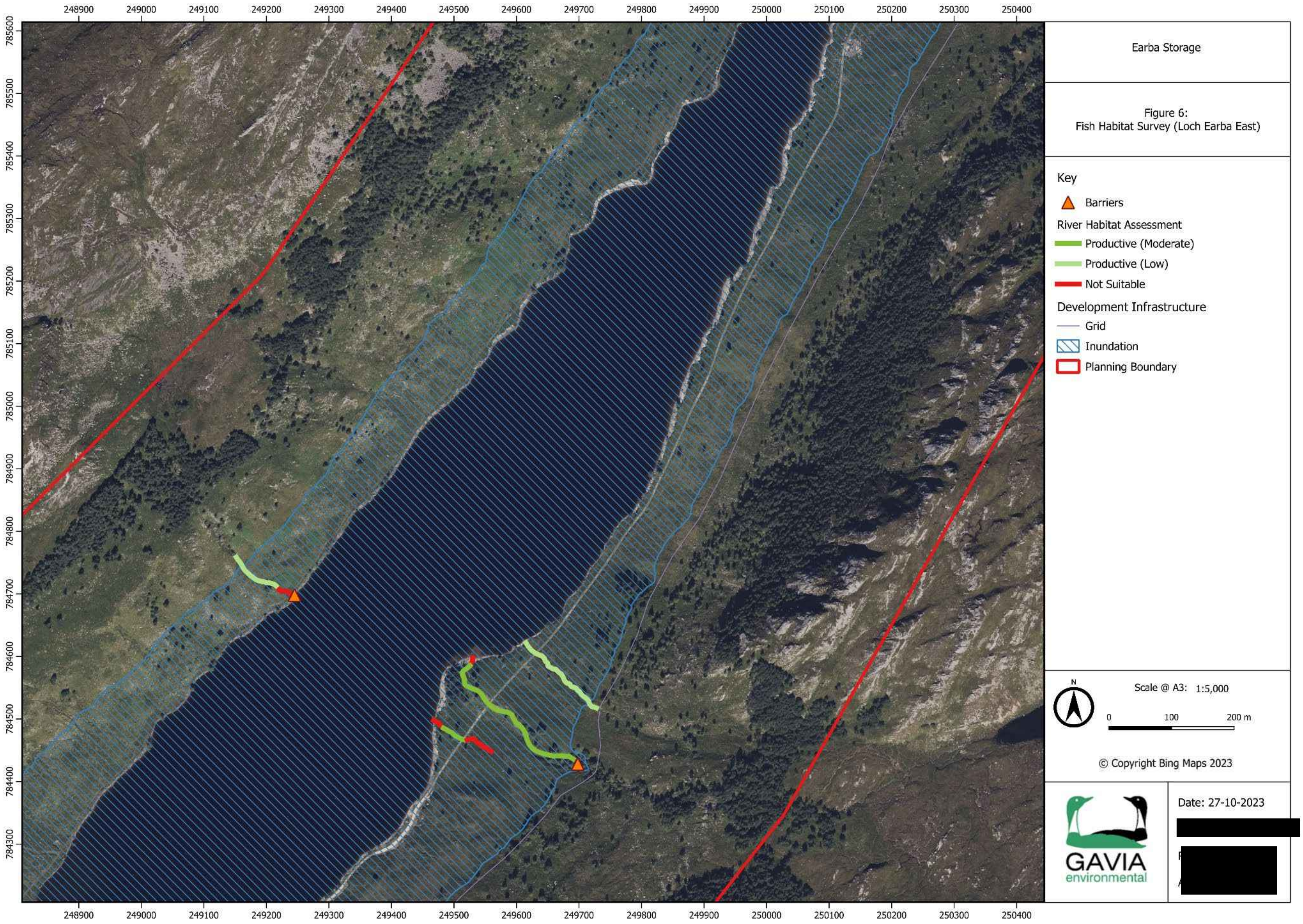
Earba Storage
Figure 6:
Fish Habitat Survey (Loch Earba East)
Key
Barriers
River Habitat Assessment
Productive (Moderate)
Productive (Low)
Not Suitable
Development Infrastructure
Grid
Inundation
Planning Boundary
Scale @ A3: 1:5,000
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N
© Copyright Bing Maps 2023
GAVIA environmental
Date: 27-10-2023
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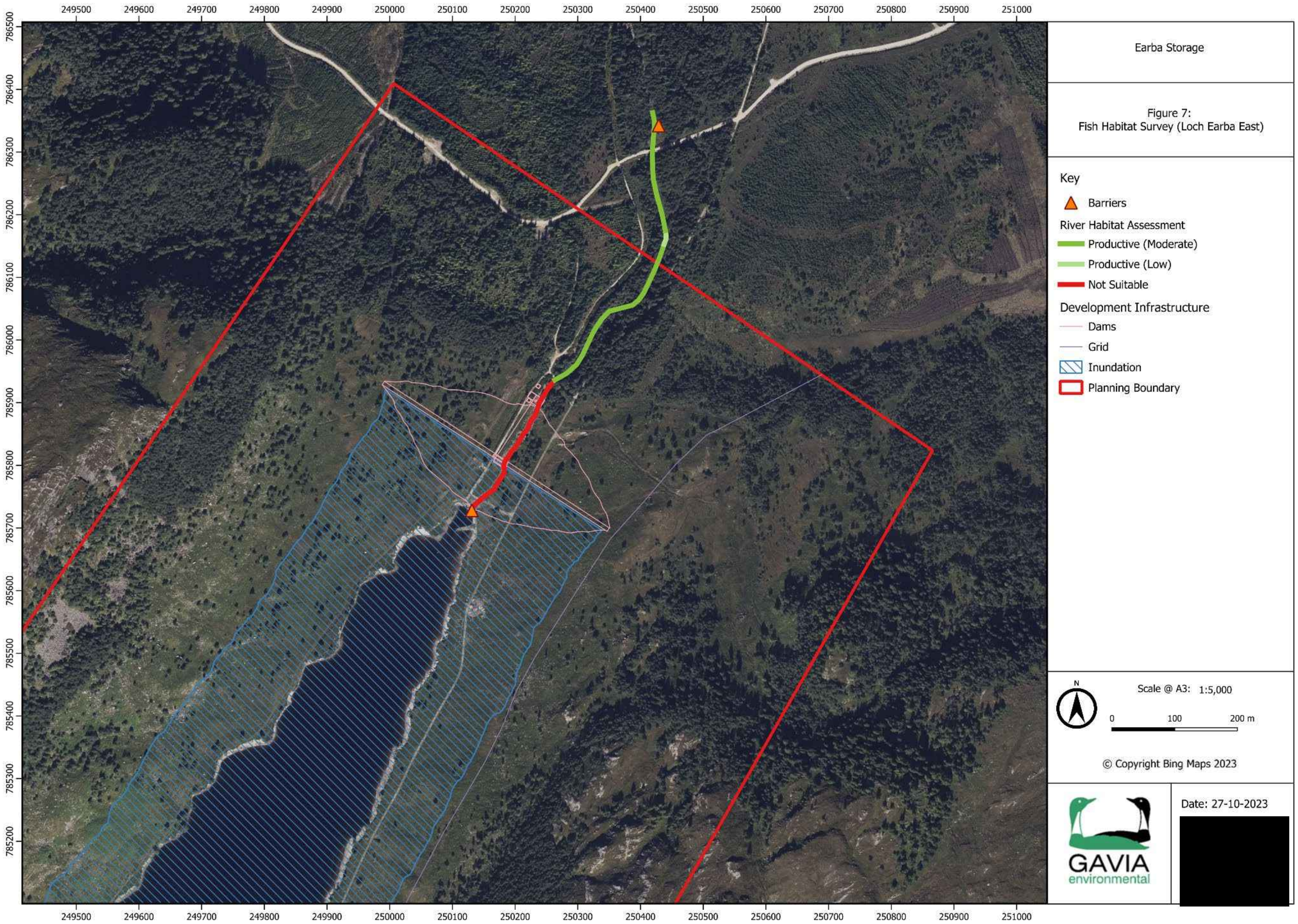
785600 785500 785400 785300 785200 785100 785000 784900 784800 784700 784600 784500 784400 784300


Earba Storage
Figure 7:
Fish Habitat Survey (Loch Earba East)
Key
Barriers
River Habitat Assessment
Productive (Moderate)
Productive (Low)
Not Suitable
Development Infrastructure
Dams
Grid
Inundation
Planning Boundary
Scale @ A3: 1:5,000
0
100
200 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 27-10-2023
[redacted]
249500
249600
249700
249800
249900
250000
250100
250200
250300
250400
250500
250600
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250900
251000
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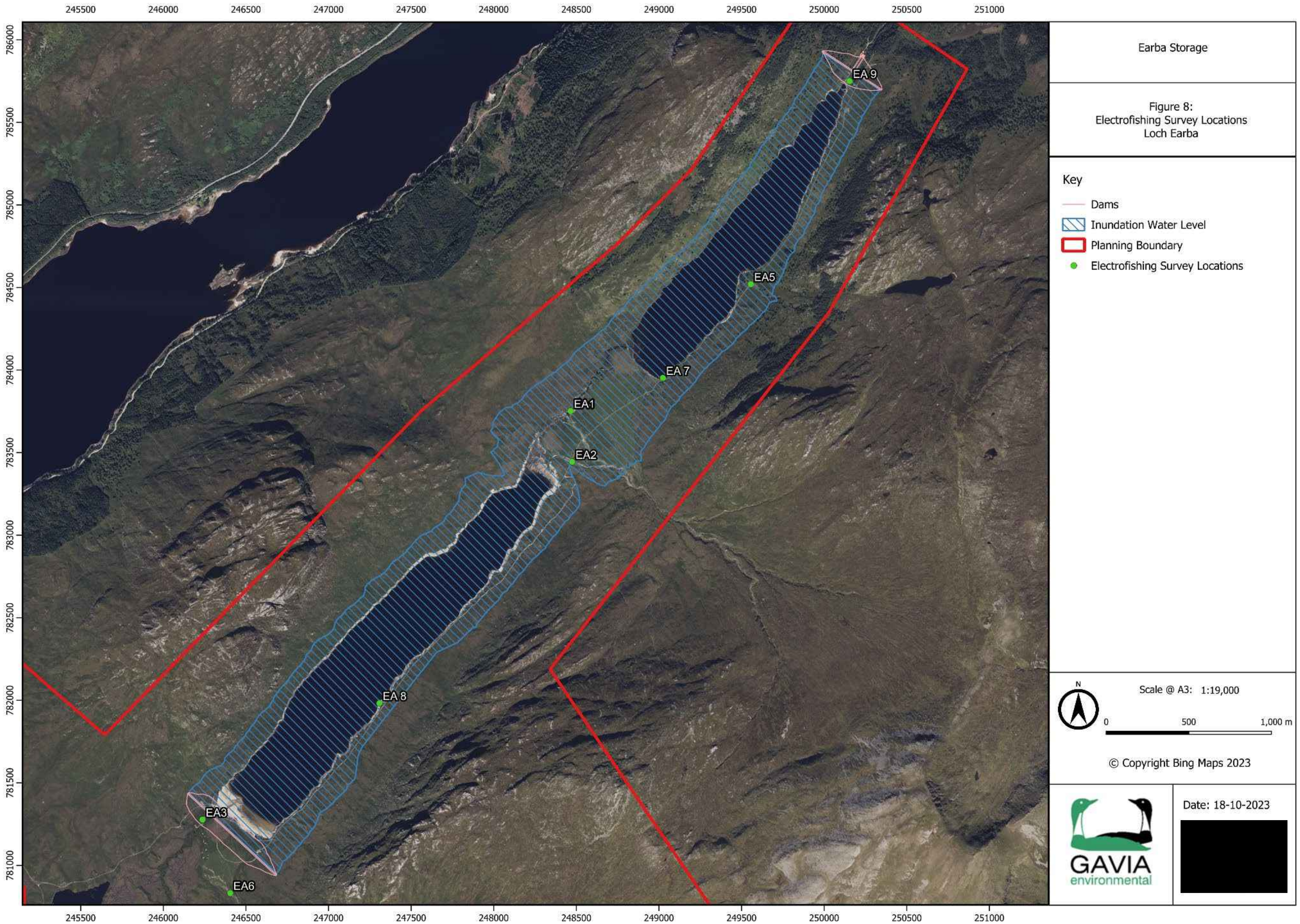
785300
785200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249500
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251000
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785000
784500
784000
783500
783000
782500
782000
781500
781000
EA 9
EA5
EA 7
EA1
EA2
EA 8
EA3
EA6
Earba Storage
Figure 8:
Electrofishing Survey Locations
Loch Earba
Key
Dams
Inundation Water Level
Planning Boundary
Electrofishing Survey Locations
N
Scale @ A3: 1:19,000
0
500
1,000 m
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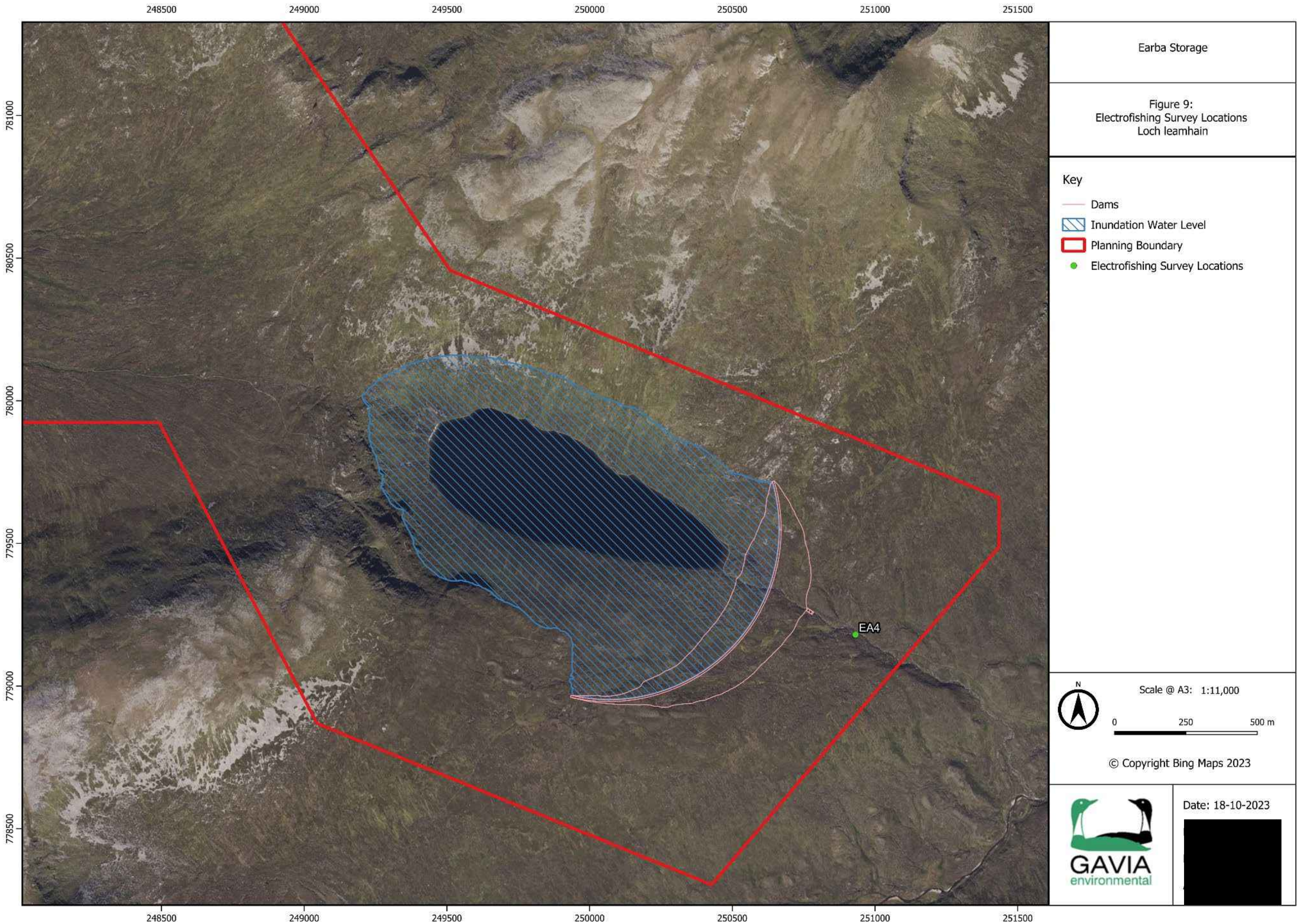
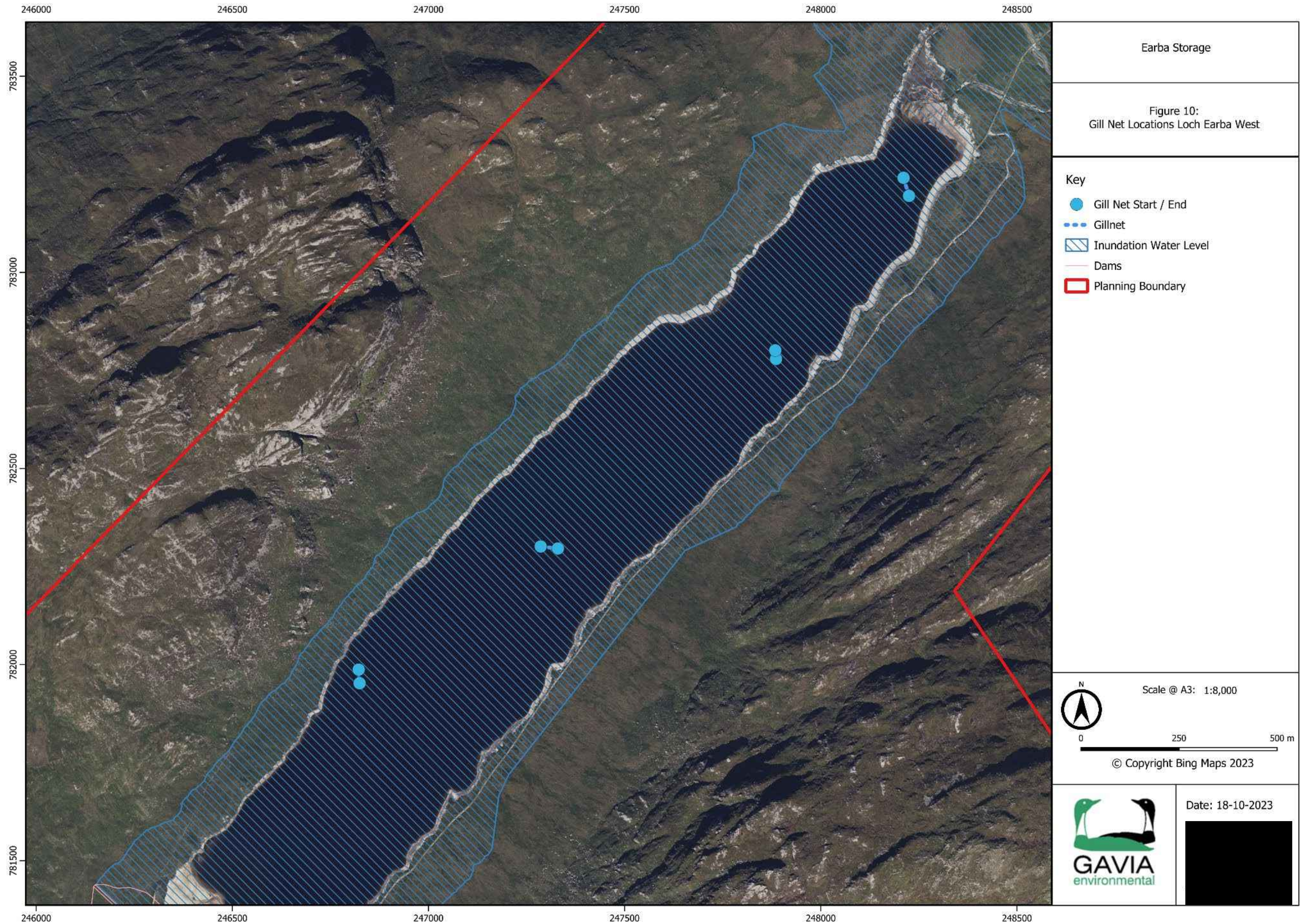
Date: 18-10-2023
[redacted]


Earba Storage
Figure 9:
Electrofishing Survey Locations
Loch Ieamhain
Key
Dams
Inundation Water Level
Planning Boundary
Electrofishing Survey Locations
EA4
248500
249000
249500
250000
250500
251000
251500
781000
780500
780000
779500
779000
778500
N
Scale @ A3: 1:11,000
0
250
500 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 18-10-2023
[redacted]


246000
246500
247000
247500
248000
248500
783500
783000
782500
782000
781500
Earba Storage
Figure 10:
Gill Net Locations Loch Earba West
Key
Gill Net Start / End
Gillnet
Inundation Water Level
Dams
Planning Boundary
N
Scale @ A3: 1:8,000
0
250
500 m
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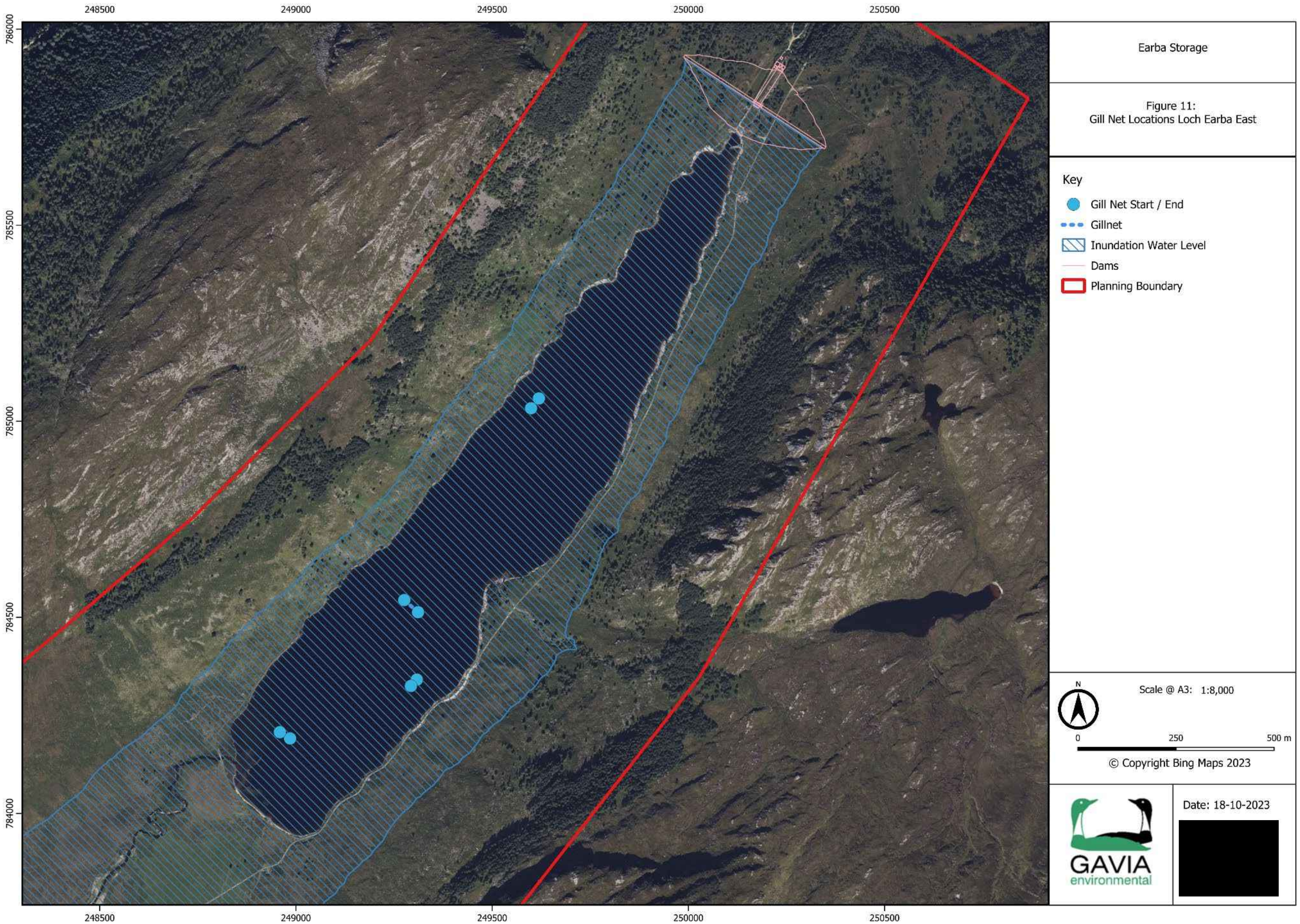
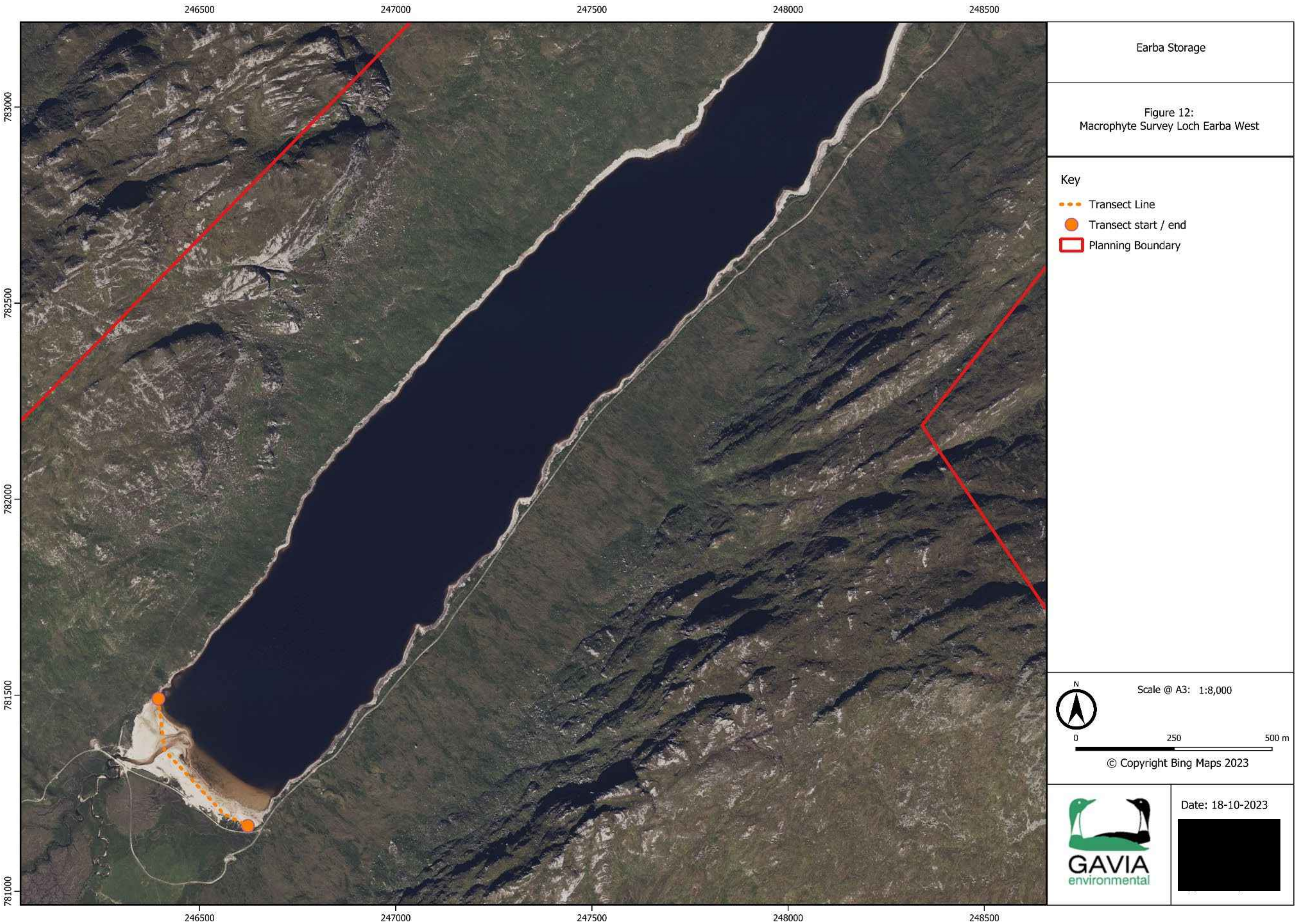
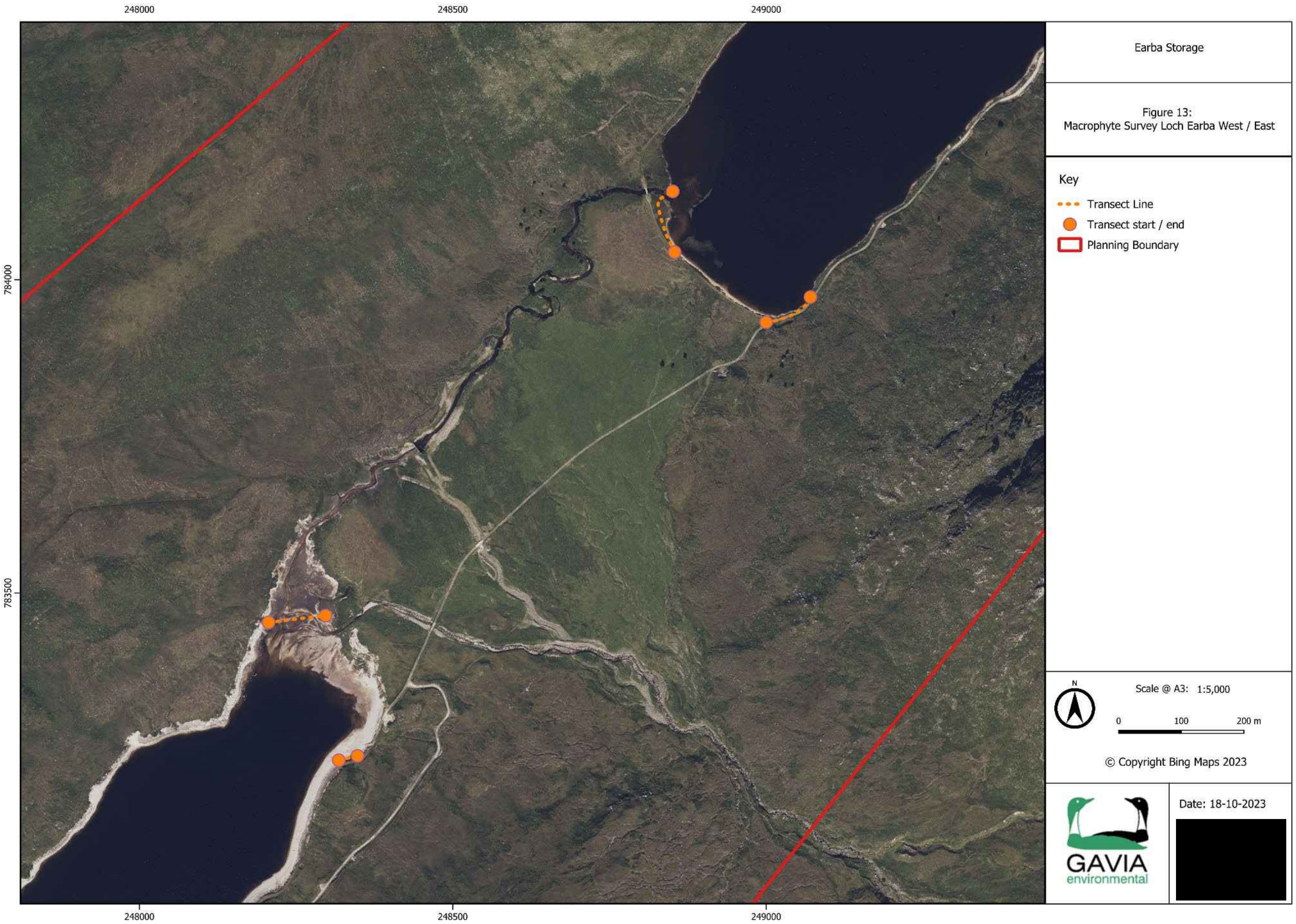
environmental
Date: 18-10-2023
[redacted]


248500
249000
249500
250000
250500
786000
785500
785000
784500
784000
Earba Storage
Figure 11:
Gill Net Locations Loch Earba East
Key
Gill Net Start / End
Gillnet
Inundation Water Level
Dams
Planning Boundary
N
Scale @ A3: 1:8,000
0
250
500 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 18-10-2023
[redacted]


246500
247000
247500
248000
248500
783000
782500
782000
781500
781000
Earba Storage
Figure 12:
Macrophyte Survey Loch Earba West
Key
Transect Line
Transect start / end
Planning Boundary
N
Scale @ A3: 1:8,000
0
250
500 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 18-10-2023
[redacted]


248000
248500
249000
784000
783500
Earba Storage
Figure 13:
Macrophyte Survey Loch Earba West / East
Key
Transect Line
Transect start / end
Planning Boundary
N
Scale @ A3: 1:5,000
0
100
200 m
© Copyright Bing Maps 2023
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Date: 18-10-2023
[redacted]

Earba Storage

Figure 14:
Macrophyte Survey Loch Earba East

Key

Transect Line

Transect start / end

Planning Boundary

Scale @ A3: 1:5,000

0 100 200 m

N

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Date: 18-10-2023

[redacted]

Appendix B Macroinvertebrate List

Table 28 Macroinvertebrate Spring Sampling Results

Order	Family	Taxa Name	MS01 Allt Labrach	MS02 Allt Loch Coire Chur	MS03 Moy Burn	MS04 L. Earba Shuas	MS05 River Earba	MS06 L. Earba Shios	MS07 Loch Leamhain	MS08 Loch Leamhain Outflow	MS09 Allt Coire Pitridh	MS10 Loch Leamhain Inflow
			17/05/2023	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*	*17/05/2023*
			Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance
BIVALVIA	SPHAERIIDAE	Euglesa conventus								5		
BIVALVIA	SPHAERIIDAE	Euglesa sp.								30		
CLADOCERA	N/A	Cladocera						18				
COLEOPTERA	DYTISCIDAE	Oreodytes sanmarkii										3
COLEOPTERA	ELMIDAE	Elmis aenea			2		1			3	3	33
COLEOPTERA	ELMIDAE	Esolus parallelepipedus								1		3
COLEOPTERA	ELMIDAE	Limnius volckmari	6	11			8		1	25		
COLEOPTERA	ELMIDAE	Oulimnius sp.							5	4		8
COLEOPTERA	ELMIDAE	Oulimnius tuberculatus							4			1
COLEOPTERA	HALIPLIDAE	Haliplus fulvus						1	2			
COLEOPTERA	HYDRAENIDAE	Hydraena gracilis								1	1	1
COLEOPTERA	SCIRTIDAE	Cyphon sp.	2									
DIPTERA	CERATOPOGONIDAE	Ceratopogonidae		1								
DIPTERA	CHIRONOMIDAE	Brillia longifurca					2			5		
DIPTERA	CHIRONOMIDAE	Chironomidae	1	7	1	8	3			30	3	24
DIPTERA	CHIRONOMIDAE	Tanypodinae								1		1
DIPTERA	CHIRONOMIDAE	Tanytarsini	1							4		2
DIPTERA	EMPIDIDAE	Clinocera sp.								1		
DIPTERA	LIMONIIDAE	Eloeophila sp.										1
DIPTERA	LIMONIIDAE	Hexatoma sp.				6		3				
DIPTERA	PEDICIIDAE	Dicranota sp.		4	2	1	6				1	2
DIPTERA	SIMULIIDAE	Prosimulium sp.			4							
DIPTERA	SIMULIIDAE	Simulium argyreatum/variegatum		1	5						30	
DIPTERA	SIMULIIDAE	Simulium sp.	1							3		4
DIPTERA	TIPULIDAE	Tipula sp.						1	1			
EPHEMEROPTERA	AMELETIDAE	Ameletus inopinatus	1			1			11			
EPHEMEROPTERA	BAETIDAE	Baetidae	3									
EPHEMEROPTERA	BAETIDAE	Baetis muticus		10	7		18			27	14	8
EPHEMEROPTERA	BAETIDAE	Baetis rhodani/atlanticus agg.		7	25	1	4			2	4	15
EPHEMEROPTERA	BAETIDAE	Centroptilum luteolum						2				
EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus dispar		1			2					

EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus sp.	1				1				2	6
EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus venosus		2	3						2	1
EPHEMEROPTERA	HEPTAGENIIDAE	Electrogena lateralis	5	1	1		2				1	1
EPHEMEROPTERA	HEPTAGENIIDAE	Heptagenia sulphurea	1									
EPHEMEROPTERA	HEPTAGENIIDAE	Heptageniidae										2
EPHEMEROPTERA	HEPTAGENIIDAE	Rhithrogena semicolorata			2						1	1
EPHEMEROPTERA	LEPTOPHLEBIIDAE	Leptophlebia vespertina	3									
EPHEMEROPTERA	SIPHLONURIDAE	Siphlonurus lacustris						8				
GASTROPODA	LYMNAEIDAE	Ampullaceana balthica	2							9		
ODONOTA	COENAGRIONIDAE	Enallagma cyathigerum						1				
ODONOTA	COENAGRIONIDAE	Pyrrhosoma nymphula	3									
ODONOTA	CORDULEGASTRIDAE	Cordulegaster boltonii	1									
OLIGOCHAETA	LUMBRICIDAE	Eiseniella tetraedra	1							1		
OLIGOCHAETA	N/A	Oligochaeta	12	2		1			1	2	3	
PLECOPTERA	CHLOROPERLIDAE	Chloroperla tripunctata			1							
PLECOPTERA	CHLOROPERLIDAE	Siphonoperla torrentium	2	2	1		2		5	1		2
PLECOPTERA	LEUCTRIDAE	Leuctra inermis		1						4	7	39
PLECOPTERA	LEUCTRIDAE	Leuctra sp.									2	
PLECOPTERA	NEMOURIDAE	Amphinemura sulcicollis		6	1		7			11	15	68
PLECOPTERA	NEMOURIDAE	Nemoura cinerea	1									
PLECOPTERA	PERLIDAE	Dinocras cephalotes	1		1		2		1	16		3
PLECOPTERA	PERLIDAE	Perla bipunctata									2	
PLECOPTERA	PERLODIDAE	Isoperla grammatica		1	2		16					4
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche pellucidula		1			93					
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche siltalai	1	2					1	71		
TRICHOPTERA	HYDROPTILLIDAE	Hydroptila sp.							8	3	9	35
TRICHOPTERA	HYDROPTILLIDAE	Oxyethira sp.										4
TRICHOPTERA	LEPTOCERIDAE	Athripsodes bilineatus					1					
TRICHOPTERA	LIMNEPHILIDAE	Limnephilidae						1				1
TRICHOPTERA	LIMNEPHILIDAE	Limnephilus lunatus						1				
TRICHOPTERA	PHILOPOTAMIDAE	Philopotamus montanus		1								1
TRICHOPTERA	POLYCENTROPODIDAE	Neureclipsis bimaculata					2					
TRICHOPTERA	POLYCENTROPODIDAE	Plectrocnemia conspersa	1									
TRICHOPTERA	POLYCENTROPODIDAE	Plectrocnemia sp.										2
TRICHOPTERA	POLYCENTROPODIDAE	Polycentropus flavomaculatus	1				1		2	1		2
TRICHOPTERA	POLYCENTROPODIDAE	Polycentropus sp.							5			2
TRICHOPTERA	RHYACOPHILIDAE	Rhyacophila dorsalis			1							
TRICHOPTERA	RHYACOPHILIDAE	Rhyacophila sp.								1		1
TRICHOPTERA	SERICOSTOMATIDAE	Sericostoma personatum	1							1		

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TROMBIDIFORMES	N/A	Hydracarina					1	1				3

Order	Family	Taxa Name	MS01 Allt Labrach	MS02 Allt Loch Coire Chur	MS03 Moy Burn	MS04 L. Earba Shuas	MS05 River Earba	MS06 L. Earba Shios	MS07 Loch Leamhain	MS08 Loch Leamhain Outflow	MS09 Allt Coire Pitridh	MS10 Loch Leamhain Inflow
			22/09/2023	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*	*22/09/2023*
			Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance	Abundance
BIVALVIA	SPHAERIIDAE	Euglesa conventus								6		
BIVALVIA	SPHAERIIDAE	Euglesa sp.							2			
CLADOCERA	N/A	Cladocera				11						
COLEOPTERA	DYTISCIDAE	Oreodytes davisii										2
COLEOPTERA	DYTISCIDAE	Oreodytes sanmarkii								1		1
COLEOPTERA	ELMIDAE	Elmis aenea			6				2	3		15
COLEOPTERA	ELMIDAE	Limnius volckmari	3	38	3		36			16	1	
COLEOPTERA	ELMIDAE	Oulimnius sp.				1	2	1		2		6
COLEOPTERA	ELMIDAE	Oulimnius tuberculatus		1			1		1			1
COLEOPTERA	HYDRAENIDAE	Hydraena gracilis		1						1		2
COLEOPTERA	SCIRTIDAE	Elodes sp.		1	1							
DIPTERA	CERATOPOGONIDAE	Ceratopogonidae				1						
DIPTERA	CERATOPOGONIDAE	Dasyhelea sp.				1	1				8	
DIPTERA	CHIRONOMIDAE	Brillia longifurca			1	1		1	1	11		1
DIPTERA	CHIRONOMIDAE	Chironomidae	4	1		1	5	1		35		4
DIPTERA	CHIRONOMIDAE	Tanypodinae	1		1	2	3		1	14		
DIPTERA	CHIRONOMIDAE	Tanytarsini	1		1		2					2
DIPTERA	DIXIDAE	Dixa sp.								2		
DIPTERA	EMPIDIDAE	Clinocera sp.		1	1							
DIPTERA	LIMONIIDAE	Hexatoma sp.					17	2				
DIPTERA	LIMONIIDAE	Neolimnomyia sp.					1					
DIPTERA	PEDICIIDAE	Dicranota sp.		2			1					2
DIPTERA	SIMULIIDAE	Simulium angustipes/velutinum					1					
DIPTERA	SIMULIIDAE	Simulium rostratum					1					
DIPTERA	SIMULIIDAE	Simulium sp.	4									
DIPTERA	TIPULIDAE	Tipula sp.				11		1	8	1		
EPHEMEROPTERA	BAETIDAE	Baetidae	1									
EPHEMEROPTERA	BAETIDAE	Baetis muticus		3			1			21	1	
EPHEMEROPTERA	BAETIDAE	Baetis rhodani/atlanticus agg.		3	8		17			138		
EPHEMEROPTERA	BAETIDAE	Baetis scambus		1								

EPHEMEROPTERA	BAETIDAE	Baetis sp.		2						36	1	9
EPHEMEROPTERA	EPHEMERELLIDAE	Serratella ignita									1	
EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus dispar			1						1	
EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus sp.		4	9				1	26	2	13
EPHEMEROPTERA	HEPTAGENIIDAE	Ecdyonurus venosus		47					5			14
EPHEMEROPTERA	HEPTAGENIIDAE	Electrogena lateralis									4	
EPHEMEROPTERA	HEPTAGENIIDAE	Heptageniidae					1					
EPHEMEROPTERA	HEPTAGENIIDAE	Rhithrogena semicolorata									1	
EPHEMEROPTERA	HEPTAGENIIDAE	Rhithrogena sp.			11							
EPHEMEROPTERA	LEPTOPHLEBIIDAE	Leptophlebia sp.	11									
EPHEMEROPTERA	LEPTOPHLEBIIDAE	Paraleptophlebia sp.			2							
GASTROPODA	LYMNAEIDAE	Ampullaceana balthica	4	1			2	3	5			
MEGALOPTERA	SIALIDAE	Sialis fuliginosa		1								
ODONOTA	COENAGRIONIDAE	Pyrrhosoma nymphula	21	1			1					
OLIGOCHAETA	LUMBRICIDAE	Eiseniella tetraedra								1		
OLIGOCHAETA	N/A	Oligochaeta	13	24	5	30	8		7	44		1
PLECOPTERA	CHLOROPERLIDAE	Chloroperla tripunctata		1								
PLECOPTERA	CHLOROPERLIDAE	Siphonoperla torrentium		3	1		2			2		2
PLECOPTERA	LEUCTRIDAE	Leuctra fusca									1	
PLECOPTERA	LEUCTRIDAE	Leuctra inermis	1	1							1	1
PLECOPTERA	LEUCTRIDAE	Leuctra sp.		1	5		1			280	1	10
PLECOPTERA	NEMOURIDAE	Amphinemura sulcicollis		4			2			17		1
PLECOPTERA	NEMOURIDAE	Nemoura avicularis		1								
PLECOPTERA	NEMOURIDAE	Nemouridae								28	2	1
PLECOPTERA	NEMOURIDAE	Protonemura meyeri		1								1
PLECOPTERA	NEMOURIDAE	Protonemura sp.		1						1	1	1
PLECOPTERA	PERLIDAE	Dinocras cephalotes			1		4		1	22	3	1
PLECOPTERA	PERLODIDAE	Isoperla grammatica					2			7		
PLECOPTERA	PERLODIDAE	Perlodes mortoni		5			9					
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche angustipennis			4		78					
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche pellucidula			6		155					
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche siltalai		5						8		
TRICHOPTERA	HYDROPSYCHIDAE	Hydropsyche sp.			6		35					
TRICHOPTERA	HYDROPTILLIDAE	Hydroptila sp.		14	64	1	27		14	73	32	103
TRICHOPTERA	HYDROPTILLIDAE	Oxyethira sp.			1		1					2
TRICHOPTERA	LEPTOCERIDAE	Athripsodes bilineatus					2					
TRICHOPTERA	LEPTOCERIDAE	Athripsodes sp.					4					
TRICHOPTERA	LEPTOCERIDAE	Mystacides azurea						1	1			
TRICHOPTERA	LIMNEPHILIDAE	Apatania wallengreni							3			

TRICHOPTERA	LIMNEPHILIDAE	Limnephilidae					1					
TRICHOPTERA	ODONTOCERIDAE	Odontocerum albicorne		2								
TRICHOPTERA	PHRYGANEIDAE	Oligotricha striata	1									
TRICHOPTERA	POLYCENTROPODIDAE	Neureclipsis bimaculata			4		52					
TRICHOPTERA	POLYCENTROPODIDAE	Plectrocnemia conspersa	1							6		
TRICHOPTERA	POLYCENTROPODIDAE	Plectrocnemia geniculata					1					
TRICHOPTERA	POLYCENTROPODIDAE	Polycentropodidae					4					
TRICHOPTERA	POLYCENTROPODIDAE	Polycentropus flavomaculatus		1	3		12		2	7	1	
TRICHOPTERA	POLYCENTROPODIDAE	Polycentropus sp.					5					
TRICHOPTERA	RHYACOPHILIDAE	Rhyacophila sp.								1		
TRICHOPTERA	SERICOSTOMATIDAE	Sericostoma personatum	2	1					1	2		
TROMBIDIFORMES	N/A	Hydracarina					4					

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Appendix C Gill Netting subsidiary information

Table 29. Gill Netting subsidiary information

Waterbody	Net Night	Net Type	Habitat	Average depth	Date (set)	Net Set	Net Collected	Trout	Charr	Minnows	Beaufort	Temperature (water)
Loch Earba East	1	Benthic	Shallow	8	12/12/2023	18:05	06:25	8	0		0	14.2
Loch Earba East	2	Pelagic	Deep	21	12/12/2023	19:40	07:40	9	0		0	14.2
Loch Earba East	3	Benthic	Deep	18.5	12/12/2023	18:15	06:30	1	0		0	14.2
Loch Earba East	4	Pelagic	Shallow	10	12/12/2023	19:25	07:30	7	0		0	14.2
Loch Earba East	5	Benthic	Shallow	8	13/12/2023	18:30	07:00	19	0		5	14.1
Loch Earba East	6	Pelagic	Deep	21	13/12/2023	18:00	06:00	25	0		5	14.1
Loch Earba East	7	Benthic	Deep	18.5	13/12/2023	18:00	06:30	0	4		5	14.1
Loch Earba East	8	Pelagic	Shallow	10	13/12/2023	18:50	07:15	5	0		5	14.1
Loch Earba West	1	Benthic	Shallow	8	30/08/2023	20:40	09:40	10	0		0	12.4
Loch Earba West	2	Pelagic	Deep	20	30/08/2023	21:50	10:00	25	0		0	12.4
Loch Earba West	3	Benthic	Deep	18.5	30/08/2023	20:55	09:50	8	0		0	12.4
Loch Earba West	4	Pelagic	Shallow	-	-	-	-	-	-	-	-	-
Loch Earba West	5	Benthic	Shallow	8	01/09/2023	17:30	06:15	26	0		3	12.4
Loch Earba West	6	Pelagic	Deep	19.5	01/09/2023	17:35	06:20	20	0		3	12.4
Loch Earba West	7	Benthic	Deep	20.5	01/09/2023	17:45	06:30	1	0		3	12.4
Loch Earba West	8	Pelagic	Shallow	12.5	01/09/2023	18:00	06:45	13	0		3	12.4

Appendix D Photographs

Plate Number	Description	Photograph
1. Macroinvertebrates		
1.1	*Apatania wallengreni*	
1.2	*Oligotrichia striata*	
1.3	*Oreodytes davisii*	

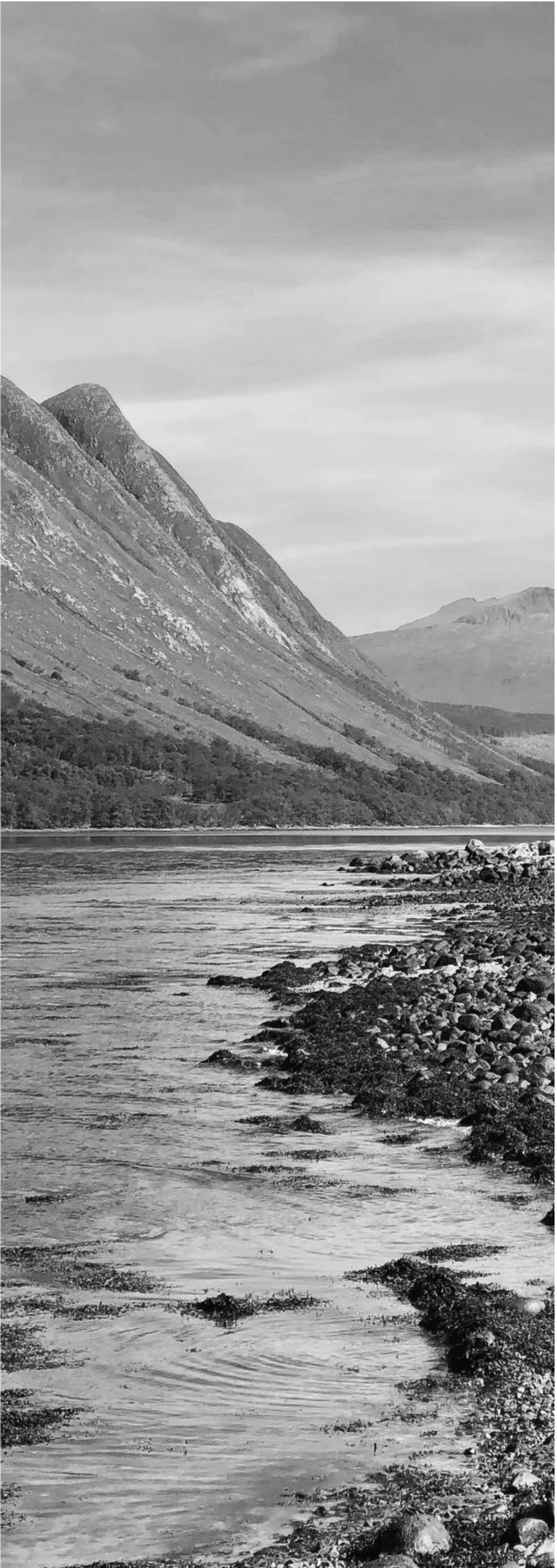
3. Fish Habitat		
3.1	Productive habitat between Loch Earba East and West	
3.2	Productive habitat on the Allt Coire a' Chlachair	
4. Electrofishing		
4.1	Brown trout identified in the outflow of Loch Leamhain	

4.2	Potential Arctic charr fry identified in the outflow of Loch Leamhain	
4.3	Potential Arctic charr fry identified in the Moy Burn	
5. Gillnetting		
5.1	A selection of Arctic charr caught via gillnetting on Loch Earba East	
5.2	Large male brown trout caught via gillnetting on Loch Earba East with distinct kype (hooked lower jaw)	

5.3	Selection of Brown trout from Loch Earba East displaying morphological variation		
6. Macrophytes			
6.1	Utrikularia bladderwort		
6.2	*Potamogeton natans*		

6.3	Marginal areas of Loch Earba West lacking macrophyte growth		
7. Other			
7.1	Otter footprint on Loch Earba East		
7.2	Invasive *Rhododendron ponticum* in the marginal areas of Loch Earba East		

Appendix E Earba Spawning Habitat Assessment (2024)



EARBA PUMPED STORAGE HYDROSCHEME

P24279 LOCH EARBA SPAWNING HABITAT ASSESSMENT

EARBA LTD.

19/12/2024

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Project name	P24279 Loch Earba Spawning Habitat Assessment
Project number	P24279
Prepared by	[redacted]
Approved by	

Revision History

Revision	Date	Prepared By	Reviewed By	Approved By	Comments
V1.0	19/12/2024	[redacted]	[redacted]	[redacted]	Initial issue

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 Earba Pumped Storage Hydroscheme, 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.

[redacted]

Contents

List of Tables

Executive Summary

Gavia Environmental Ltd. was commissioned by Earba Ltd. (hereafter 'The Client') to undertake a spawning habitat assessment within Lochan na h-Earba (hereafter referred to as Loch Earba) in relation to the proposed Earba Pumped Storage Hydroscheme (PSH).

It was agreed with SEPA that a spawning habitat assessment would be conducted on Loch Earba (both basins) via a ROV (Remotely Operated Vehicle) or a suspended Spyball camera deployed from a boat.

Ten equidistant transects, per basin, were conducted over the width of Loch Earba (these ranged from 100m - 400m in length). The first and last 15m of each transect was recorded in full (measured in distance from the water's edge at the time of survey) and thereafter spot checks were conducted every 50m, or at appropriate intervals dependent on transect length. These were prepopulated using GIS mapping prior to the field survey. This concentrated survey efforts in the areas of Loch Earba most likely to contain suitable spawning habitat as Arctic charr tend to utilise shallower littoral zone areas for spawning but are known to occasionally spawn at greater depths[1]. Within each 15m section or spot check the substrate composition was noted as a percentage of each substrate size present. Substrate sizes were based on SFCC descriptions.

Analysis of the collected habitat data was conducted on review of the video footage captured. An adapted Coyle and Adams, 2011 methodology was followed. The Coyle and Adams 2011 methodology was developed for assessing Vendace (*Coregonus albula*) spawning habitat.
For 'optimal' vendace habitat, any two or more inorganic stony substrates must be present, with less than 10% organic silt present, ranging in size from gravel to boulder and comprising at least 30 % of the area. However, literature sources specific to Arctic Charr cite the availability of clean gravels as key to spawning (Johnson, 1980, Natural England, 2019). Brown trout have similar preferences, stable gravel up to 30 cm deep that is not compacted and does not contain excessive silt. Substrate size varies from gravels, pebbles and smaller cobbles depending on fish size. On this basis where 'optimal' habitat was recorded based on the Coyle and Adams methodology, this was downgraded to 'sub-optimal' or 'poor' habitat if there was a lack of gravel present to be more specific to Arctic charr and Brown trout which are the species of relevance in Loch Earba.

A total of 713m of transect length was surveyed, which included 15m from the water's edge at the time of survey and the remaining section of any dry, non-inundated shore to where the soil / vegetated bank starts, which was considered the point where the loch basin would be at full capacity.

Of the 713m of transect surveyed, 477m (67%) was classified as 'poor', 83m (12%) was classified as 'sub-optimal' and 154m (21%) was classified as 'optimal' for spawning habitat based on the information collected on the physical habitat character at the time of survey.

Of the 120 point locations surveyed within deeper water locations across the transects, 117 (97.5%) were classified as 'poor', 2 (1.67%) were classified as 'sub-optimal' and 1 point (0.83%) was classified as 'optimal' (albeit this was located immediately beyond the 15m transect limit).

The depths taken at point locations surveyed ranged from 0.4 - 24.4m with an average depth of 11.4m. Point locations were typically at least 50m out from the water's edge and extended across the loch giving a good coverage of a range of depths in combination with the 15m transects.

[1] 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.

A secondary analysis of the spawning habitat assessment data based on GIS shapefiles of the current minimum loch level has been undertaken to assess the likely impact of post-spawning aerial egg exposure potential. Based on this analysis, more than half (56.2%) of the surveyed habitat transect length is situated above the minimum loch water level. The results of this secondary analysis indicate that under the lowest allowable current water level, 45.6m (6.4%) of the surveyed transects are assessed as 'optimal and hydrologically viable', 12m (1.8%) are assessed as 'sub-optimal and hydrologically viable', and 254m (35.6%) are assessed as 'poor and hydrologically viable'.

Based on the results of this study, there is little or no spawning opportunities for Arctic charr in the deeper areas of both basins of Loch Earba beyond 15m from the water's edge, therefore it is likely that they either utilise 'optimal' / 'sub-optimal' areas along the wetted littoral zone or the inflowing tributaries for spawning.

Analysis of the potential effect of seasonality and the existing hydro scheme indicates that the loch margins offer very little optimal or sub-optimal habitat under the loch's current operational regime.

It is considered that the relative absence of suitable spawning habitat is likely to be a significant contributing factor to the small population size of the Arctic charr believe to be resident in Loch Earba East.

The fluctuations in loch levels due to seasonality and the existing hydro scheme is likely to have an impact on spawning success and egg viability within the littoral zone as some areas featuring optimal substrate types will be prone to drying out, having been previously inundated.

1 Introduction

Gavia Environmental Ltd. was commissioned by Earba Ltd. (hereafter 'The Client') to undertake a spawning habitat assessment within Lochan na h-Earba (hereafter referred to as Loch Earba) in relation to the proposed Earba Pumped Storage Hydro scheme (PSH). Although Loch Earba is considered to be one waterbody, it is considered to have two basins (separated by a river and dam) hereafter referred to as Loch Earba East (approximate grid reference NN 49477 84783) and Loch Earba West (approximate grid reference NN 47315 82322). The lochs drain from west to east with the outflow being the Allt Labhrach which flows towards Loch Laggan.

This document has been compiled as an addendum to the Earba Pumped Storage Hydroscheme Aquatic Ecology Technical Appendix for the CAR Licence Application report which was issued in December 2024, to inform a CAR Licence application for the proposed Earba PSH scheme.

1.1 Background

The client is proposing to construct a new long-scale long duration 1800 MW pumped storage hydroscheme and associated infrastructure on Loch Earba and 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 (approximately 1.9 km^2) of peripheral habitat will be inundated (submerged in water) as shown in **Appendix A, 'Proposed Development'**. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

1.2 Scoping and Consultation

To inform the scope of the assessment for the Proposed Development, consultation was undertaken with statutory and non-statutory bodies. Full details of the consultation responses and scoping opinion specific to Aquatic Ecology can be reviewed in the EIAR: Chapter 11.

SEPA was consulted on the proposed aquatic surveys and the methodologies employed; revisions were made to the document accordingly.

Additional surveys were requested by SEPA in relation to the CAR Licence application for the Proposed Development, and included this spawning habitat assessment.

1.3 Survey dates

Dates surveys were conducted on are provided in **Table 1**.

Table 1. Survey Dates

Field Survey	Survey Dates	Surveyors
Spawning Habitat Assessment	2nd – 6th September 2024	[redacted]

2 Methodology

2.1 Desk Study

A desktop study was carried out at the start of the commission and ahead of the field survey. Information sources used for this study are described below:

- Bing Maps – aerial imagery was obtained and used to inform the field survey;
- Ordnance Survey Map – site mapping was reviewed to inform survey location selection; and
- National Library of Scotland – bathymetric data on waterbodies.

2.2 Field Surveys

2.2.1 Spawning Habitat Assessment

Following agreement with regulators SEPA (email Reference *RE: Earba PSH - CAR Licence Application - Fish Survey Methodology* - 08/08/2024), it was proposed that a spawning habitat assessment would be conducted on Loch Earba (both basins) via a ROV (Remotely Operated Vehicle) or a suspended Spyball camera deployed from a boat. It was agreed that ten equidistant transects, per basin, would be conducted over the width of Loch Earba (these ranged from 100m - 400m in length). The first and last 15m of each transect was recorded in full (measured in distance from the water's edge at the time of survey) and thereafter spot checks were conducted every 50m. These were prepopulated on a tablet using GIS mapping prior to the field survey. This concentrated survey efforts in the areas of Loch Earba most likely to contain suitable spawning habitat within transects with a representative sample of deeper areas taken via spot locations. Within each 15m section or spot check the substrate composition was noted as % of each substrate size present. Other factors such as the presence of macrophytes were noted. Spot checks were microsited in the case of large boulder erratics to allow the Spyball camera to be manoeuvred sufficiently to determine substrate composition. Where water depth was too shallow to employ a Spyball camera (<0.5m), a bathyscope was used and the section was waded so that the substrate types could be recorded manually.

Dry substrate from the edge of the bankside where the vegetation started to the water's edge was also recorded and included within the assessment however this habitat was considered to offer limited spawning opportunities due to it being dry at the time of survey.

Additional information was collected at the point of survey including water levels and preceding weather conditions (including rainfall). The survey did not include watercourses which are already captured in watercourse fish habitat assessments.

An electronic tablet with pre-determined transects and point locations was utilised in the field which allowed easier boat navigation and data entry.

Weather conditions were generally calm and bright on the days of survey which allowed for easier manoeuvring of the boat, allowing a clearer picture on the Spyball control unit for analysis. For deeper darker areas, the Spyball is equipped with an LED light which illuminates the loch bed.

Data Analysis

Analysis of the collected habitat data was conducted on review of the video footage captured. An adapted Coyle and Adams, 2011 methodology was followed. The Coyle and Adams 2011 methodology was developed for assessing Vendace (*Coregonus albula*) spawning habitat.

For 'optimal' vendace habitat, any two or more inorganic stony substrates must be present, with less than 10% organic silt present, ranging in size from gravel to boulder and comprising at least 30 % of the area. However, literature sources specific to Arctic Charr cite the availability of clean gravels as key to spawning (Johnson, 1980, Natural England, 2019). On this basis where 'optimal' habitat was recorded based on the Coyle and Adams methodology, this was downgraded to 'sub-optimal' or 'poor' habitat if there was a lack of gravel present.

Loch Earba is part of the existing Ardverikie Hydro scheme and features dam impoundments which can artificially raise or lower loch levels, out with natural levels. Where optimal substrates were found on dry areas beyond the water's edge, these were downgraded to 'sub-optimal' due to the strong likelihood that they are not always wetted during the sensitive period for spawning and egg development.

As the lochs surveyed are already modified by the existing hydropower scheme, the loch levels in both basins of Loch Earba are subject to artificial water level change. This modified hydrological regime has particular relevance to potential spawning habitat for Arctic charr (and other fish) in that habitats which are physically optimal for spawning due to their marginal position which is subject to wave washing, may become aerially exposed due to water level reductions during the egg development period following spawning. To assess the potential impact of the current hydro scheme's operation on spawning habitat in the lochs, a secondary stage of habitat assessment has been undertaken to assess what practical impact the lochs' current operational regime has on the level of spawning habitat which is both physically optimal but also hydrologically viable throughout the egg development period.

This assessment has been undertaken using GIS comparison of the results of the primary spawning habitat assessment (based on field observations) combined with mapped shapefiles of the lochs' at their lowest allowable level based on the operation of the current hydroscheme. A further set of spawning habitat classifications have been derived based on this secondary assessment. Water level data from the period between 2018 to 2024 shown in figure 1 below indicates the lochs are regularly drawn down to within 10% of their lowest allowable level. Therefore, it is considered that the results of the secondary spawning habitat assessment analysis represents a common scenario which occurs during the egg development period of most years.

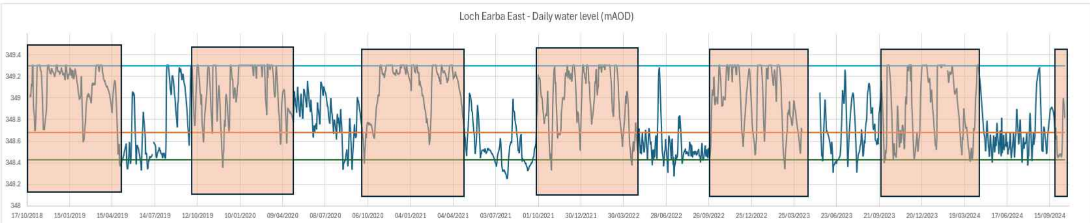


Figure 1. 2018-2024 daily water levels in Loch Earba East, with egg development periods indicated.

2.2.2 Limitations to Survey

GPS accuracy can be an issue in the field when navigating to predetermined spawning habitat transect and point locations on a tablet (typically accurate to <5m). For open water point locations, inaccuracies in GPS are not likely to have affected the outcome of the survey results due to the homogeneity of the substrate across these areas. For 15m transects, ground truthing of the GPS locations was carried out by comparing the GPS location on the tablet screen aerial background against surrounding landscape and bankside morphology to ensure geographical accuracy of the data collected.

On review of available aerial mapping (Bing Maps) which showed the loch at a much lower level (than at the time of survey), there were areas graded as 'optimal' spawning habitat at the time of survey, recorded on wetted areas which look to periodically dry out during periods of lower held water levels. Fluctuating or dropping water level increases the likelihood of desiccation of fish eggs, leading to unsuccessful egg development. This presents a limitation to the data analysis as there may be an over-estimation of viable 'optimal' spawning habitat due to the increased wetted area at the time of survey. No historical water level data was available for Loch Earba prior to undertaking the field survey. Loch levels were considered high at the time of survey after periods of heavy rainfall, with water levels within the loch basins considered almost at full capacity.

No 15m transects were carried out at the narrower ends of each loch basin. The habitat in these areas tended to feature deposits of uniform sand and mud which is unsuitable for salmonid spawning. The western end of Earba-West basin may feature some suitable gravels but this area of the loch is affected by high quantities of macrophyte growth. The transects surveyed are considered representative of the habitat present within each basin.

The accuracy of the secondary spawning habitat assessment is highly contingent on the accuracy of the lowest water level shapefile provided. This shapefile has been accepted as accurate in good faith.

3 Results

3.1 Spawning Habitat Assessment (Field observations)

3.1.1 Transect Data (15m)

A total of 713m of transect length was surveyed, which included approximately 15m from the water's edge at each transect end at the time of survey and the remaining section of dry shore to the bank where the terrestrial vegetation started. Full transect data with percentages of substrate types is provided in **Appendix B**, **Table 4** and shown in **Figure 2.1 – 2.2.**

Of the 713m of transect surveyed, 477m (67%) was classified as 'poor', 82m (12%) was classified as 'sub-optimal' and 154m (21%) was classified as 'optimal' for spawning habitat based on the information collected at the time of survey.

Table 2. Transect Data (15m)

Classification	Length (m)	Percentage
Optimal	154	21.6%
Sub-Optimal	82	11.5%
Poor	477	66.9%
Total	**713**	**100%**

3.1.2 Point Location Data (50m Spot Checks)

A total of approximately 120 point locations were surveyed, at 50m intervals across each of the 20 transects. Point locations were typically out with the 15m transects. Full point location data with percentages of substrate types is provided in **Appendix B**, **Table 5** and shown in **Figures 3.1-3.4.**

Of the 120 point locations surveyed, 117 (97.5%) were classified as 'poor', 2 (1.67%) were classified as 'sub-optimal' and 1 point (0.83%) was classified as 'optimal'.

Table 3. Point Location Data (50m Spot Checks)

Classification	No. of Points	Percentage
Optimal	1	0.83%
Sub-Optimal	2	1.67%
Poor	117	97.5%
Total	**120**	**100%**

3.2 Spawning Habitat Assessment (Secondary analysis)

3.2.1 Rationale

The primary spawning habitat assessment is based on 'on-the-day' observations of loch level. The loch level at the time of the survey was relatively high, which has led to areas of spawning habitat classified as optimal (based on physical characteristics, the primary methodology employed) being situated above the level to which the loch can be lowered by the current hydro scheme's operation. Water level data from the years 2018 to 2024 shown in Figure 1 shows it is typical for the lochs to be drawn down to within 10% of their lowest allowable level. during the egg development period (Late September to late April). As a result, some areas of marginal spawning habitat which are physically optimal are in practical terms non-viable, as all eggs laid in these areas are at risk of aerial exposure, leading to their total loss.

To quantify this, the results of the primary spawning habitat assessment have been further sub-divided into categories 'Within' (that is, below) the minimum level of the lochs, and 'outwith' (that is, above) the minimum level of the lochs. This issue only affects the transect data from the primary assessment (i.e. the marginal transects) rather than the Point location data (50m spot checks). The vast majority of the point location data (>99%) indicated poor or sub-optimal habitat conditions in any event.

3.2.2 Transect Data (15m)

A total of 713m of transect length was re-analysed, which included 15m from the water's edge at the time of survey and the remaining section of dry shore to the bank where the vegetation started with the minimum loch level shape file superimposed upon it. Refined transect data is shown in **Figure 2.3 – 2.4.**

Of the 713m of transect re-analysed, 70.4% primarily assessed as optimal are outwith the minimum water level, 84.6% primarily assessed as sub-optimal are outwith the minimum water level, and 46.7% primarily assessed as poor are outwith the minimum water level. This analysis indicates that the residual optimal **and** viable habitat percentage is 6.4%, the residual sub-optimal **and** viable habitat percentage is 1.8%, and the residual poor **and** viable habitat percentage is 35.6%. Therefore, 56.2% of the total surveyed transect habitat is outwith the minimum loch level, and therefore is unlikely to be viable spawning habitat in most years.

Table 4. Transect Data (15m)

Classification	Length (m) (Within)	Percentage (Within)	Length (m) (Outwith)	Percentage (Outwith)	Combined length (m)
Optimal	45.6	6.4%	108.6	15.2%	154.2
Sub-Optimal	12.6	1.8%	69.2	31.3%	81.8
Poor	254.1	35.6%	222.8	9.7%	476.9
Sub-total	**312.3**	**43.8%**	**400.6**	**56.2%**	**712.9**

4 Discussion

4.1 Spawning Habitat Assessment

4.1.1 Transect Data (15m)

Of the 713m of transect surveyed, 477m (67%) was classified as 'poor', 82m (12%) was classified as 'sub-optimal' and 154m (21%) was primarily classified as 'optimal' for spawning habitat based on the information collected at the time of survey.

Transects were typically characterized by large boulder substrate at the banksides. Beyond this, the transitional areas, featuring waved washed areas appeared to offer the best combinations of substrate with more availability of clean gravels and pebbles over short sections. Moving beyond this the transects typically became poor with a greater presence of sand and organic silt deposits and within the photic zone, rooted aquatic macrophytes were abundant, which typically present poor spawning habitat.

4.1.2 Point Location Data (50m Spot Checks)

Of the 120 point locations surveyed, 117 (97.5%) were classified as 'poor', 2 (1.67%) were classified as 'sub-optimal' and 1 point (0.83%) was classified as 'optimal'.

Arctic charr populations are known to primarily utilise loch marginal habitat for spawning, 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). The depths of point locations surveyed ranged from 0.4 - 24.4m with an average depth of 11.4m. Point locations were typically at least 50m out from the water's edge and extended across the loch giving a good coverage of a range of depths in combination with the 15m transects. The only optimal rated point location actually fell just outside 15m from the water's edge and at a depth of 1.5m. Any of the points beyond 15m from the water's edge predominantly featured 'poor' habitat.

Due to the very limited 'optimal' / 'sub-optimal' spawning habitat recorded at point locations, with the habitat predominantly 'poor', it is very unlikely that Arctic charr are utilising deeper areas for spawning within the Loch Earba basins.

4.2 Spawning habitat assessment (Secondary analysis)

Following secondary analysis of spawning habitat assessment data relative to the impacts of the current hydro scheme's water level regime, 56.2% of the surveyed habitat transects are situated outwith (that is, above) the minimum water level of the lochs. This proportion of the surveyed habitat may therefore be non-viable for spawning in some years. As physically optimal spawning habitat is typically found in shallow water marginal areas most immediately affected by water level reduction, the potential effect of the current water level regime disproportionately affects the physically optimal habitat. Following the secondary spawning habitat assessment, 108m primarily classified as 'optimal' is potentially non-viable, 69m primarily classified as 'sub-optimal' is potentially non-viable and 223m primarily classified as 'poor' is potentially non-viable.

Taken together, the results of both the primary habitat assessment and the secondary habitat analysis, indicate that 45m (6.4%) of surveyed transect habitat is classified as 'physically optimal and hydrologically viable', 12m (1.8%) of surveyed transect habitat is classified as 'physically sub-optimal and hydrologically viable', and 254m (35.6%) of surveyed transect habitat is classified as 'physically poor and hydrologically viable'

5 Conclusion

Based on the results of this study, there are little or no spawning opportunities for Arctic charr in the deeper areas of both basins of Loch Earba, therefore it is likely that they either utilise 'optimal' / 'sub-optimal' areas along the wetted littoral zone or the inflowing tributaries for spawning.

On physical characteristics alone, 154m (21%) of the surveyed transects are classified as 'optimal', 82m (12%) of the surveyed transects are classified as 'sub-optimal', and 477m (67%) of the surveyed transects are classified as 'poor'.

The fluctuation in loch levels due to operation of the existing Ardverikie hydroscheme has an impact on spawning habitat availability and egg viability within the littoral zone as some areas featuring optimal substrate types will be prone to drying out, having been previously inundated.

A secondary assessment has been undertaken to estimate the potential impact on spawning habitat availability due to existing Ardverikie hydroscheme. Based on this assessment, more than half (56.2%) of the surveyed habitat transects are situated above the minimum loch water level. This impact disproportionately affects the physically 'optimal' habitat. As a result, the residual spawning habitat is classified as 45m (6.4%) 'optimal', 12m (1.8%) as 'sub-optimal' and 254m (35.6%) as 'poor'.

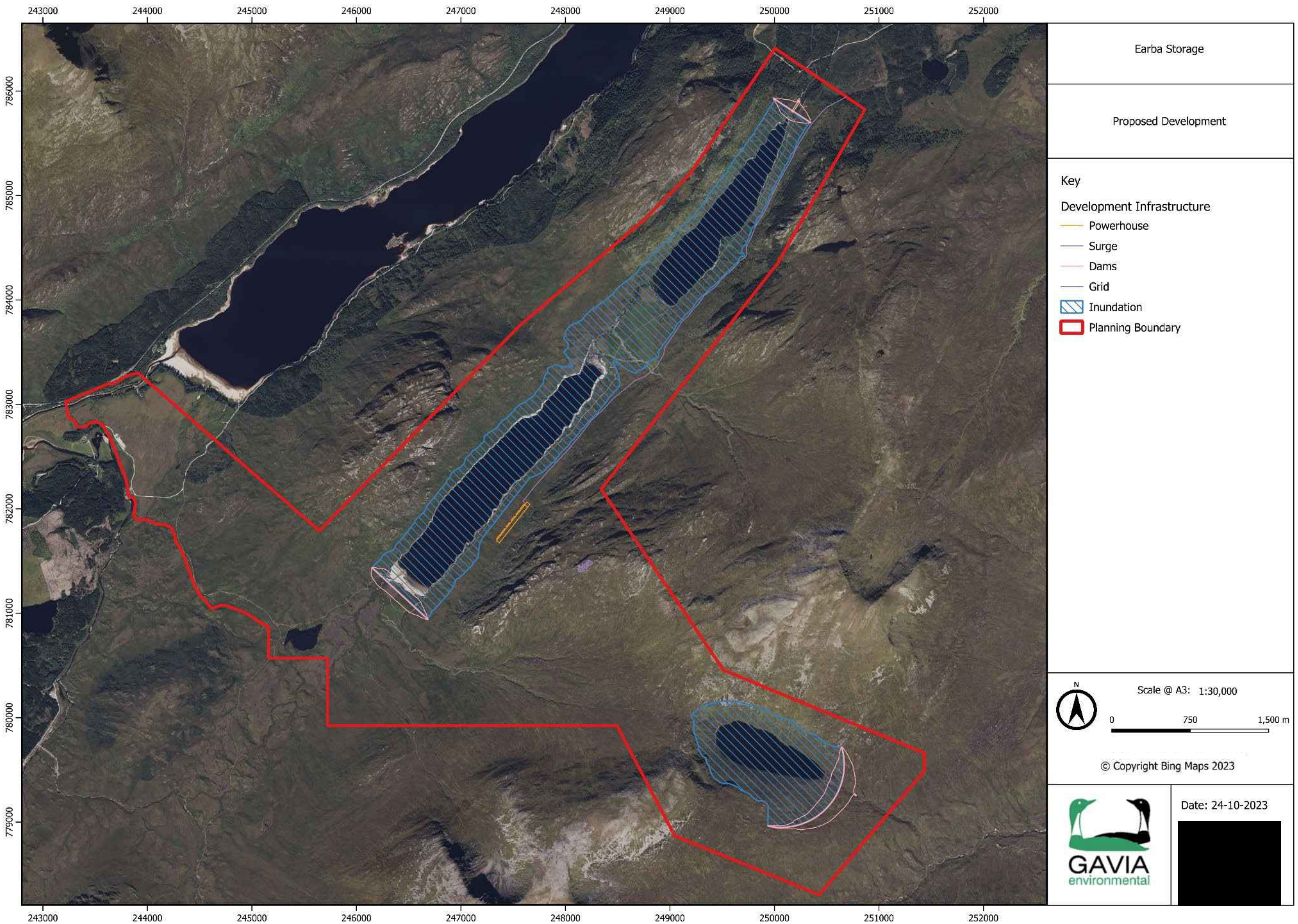
The significantly limited availability of optimal and sub-optimal spawning habitat is considered a significant factor contributing to the likely small population of Arctic charr in Loch Earba in its current condition.

References

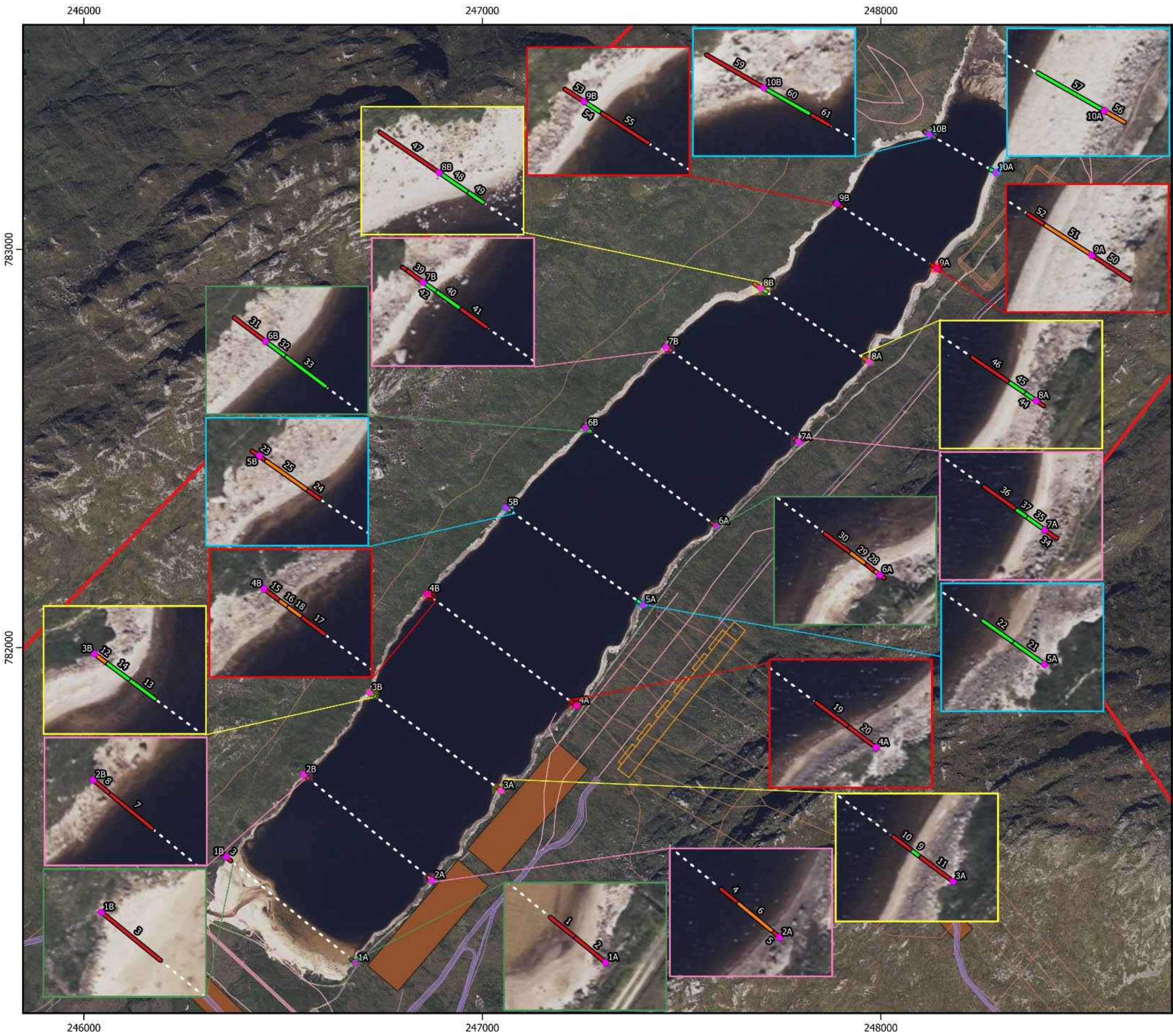
[redacted]

Appendices

Appendix A Figures



Earba Pumped Storage Hydroscheme



Earba Storage – Loch Earba
Spawning Habitat Assessment

Figure 2.1:
Transect Data (15m Transects)
Earba West Basin

Key

Development Infrastructure
- Planning Boundary
- PSH Tracks - modelled
- PSH Tracks - unmodelled
- Powerhouse
- Surge
- Dams
- Peninsula
- Grid
- Estate Tracks
- Estate Footpaths
- BP
- Aqueduct and Diversion
- Adit
- Tunnel
- Compounds

Spawning Habitat Assessment 2024
- Water Level During Survey

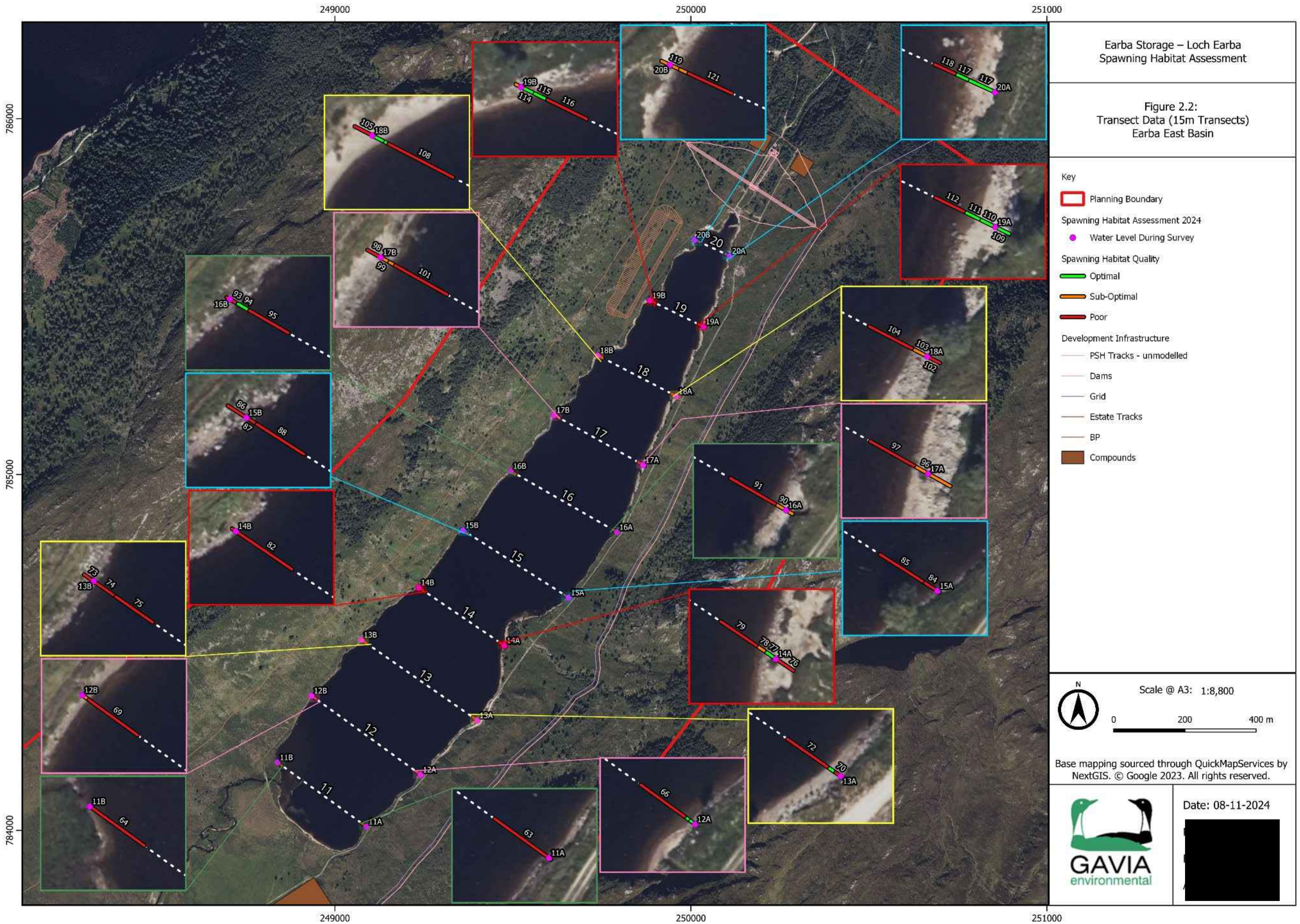
Spawning Habitat Quality
- Optimal
- Sub-Optimal
- Poor

Scale @ A3: 1:8,800

0 200 400 m

GAVIA environmental

Date: 08-11-2024
[redacted]
Reviewed By [redacted]
Approved By [redacted]


Earba Storage – Loch Earba
Spawning Habitat Assessment
Figure 2.2:
Transect Data (15m Transects)
Earba East Basin
Key
Planning Boundary
Spawning Habitat Assessment 2024
Water Level During Survey
Spawning Habitat Quality
Optimal
Sub-Optimal
Poor
Development Infrastructure
PSH Tracks - unmodelled
Dams
Grid
Estate Tracks
BP
Compounds
N
Scale @ A3: 1:8,800
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400 m
Base mapping sourced through QuickMapServices by NextGIS. © Google 2023. All rights reserved.
GAVIA
environmental
Date: 08-11-2024
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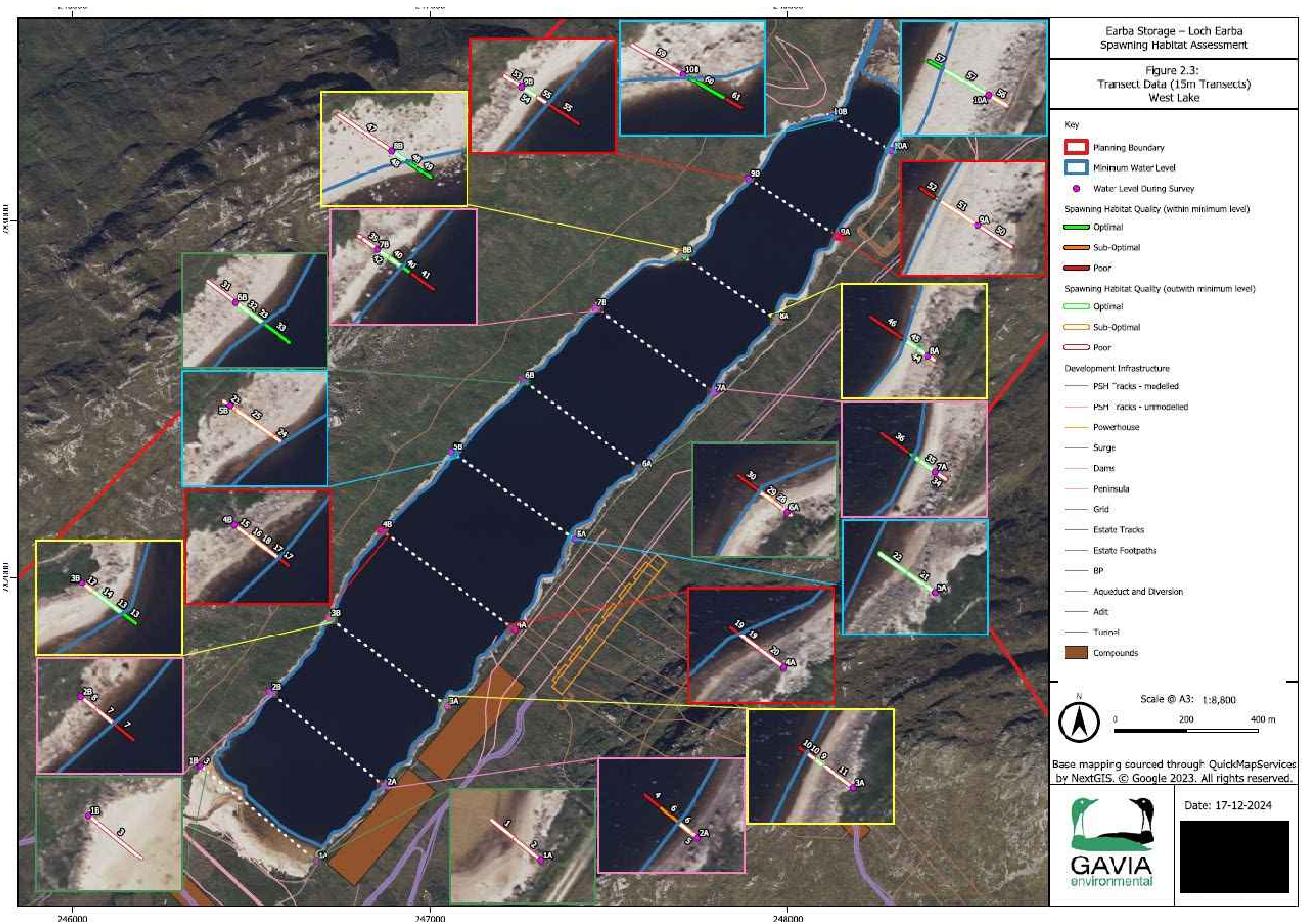
Earba Storage – Loch Earba
Spawning Habitat Assessment
Figure 2.3:
Transect Data (15m Transects)
West Lake
Key
Planning Boundary
Minimum Water Level
Water Level During Survey
Spawning Habitat Quality (within minimum level)
Optimal
Sub-Optimal
Poor
Spawning Habitat Quality (outwith minimum level)
Optimal
Sub-Optimal
Poor
Development Infrastructure
PSH Tracks - modelled
PSH Tracks - unmodelled
Powerhouse
Surge
Dams
Peninsula
Grid
Estate Tracks
Estate Footpaths
BP
Aqueduct and Diversion
Adit
Tunnel
Compounds
N
Scale @ A3: 1:8,800
0
200
400 m
Base mapping sourced through QuickMapServices by NextGIS. © Google 2023. All rights reserved.
GAVIA environmental
Date: 17-12-2024
[redacted]
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247000
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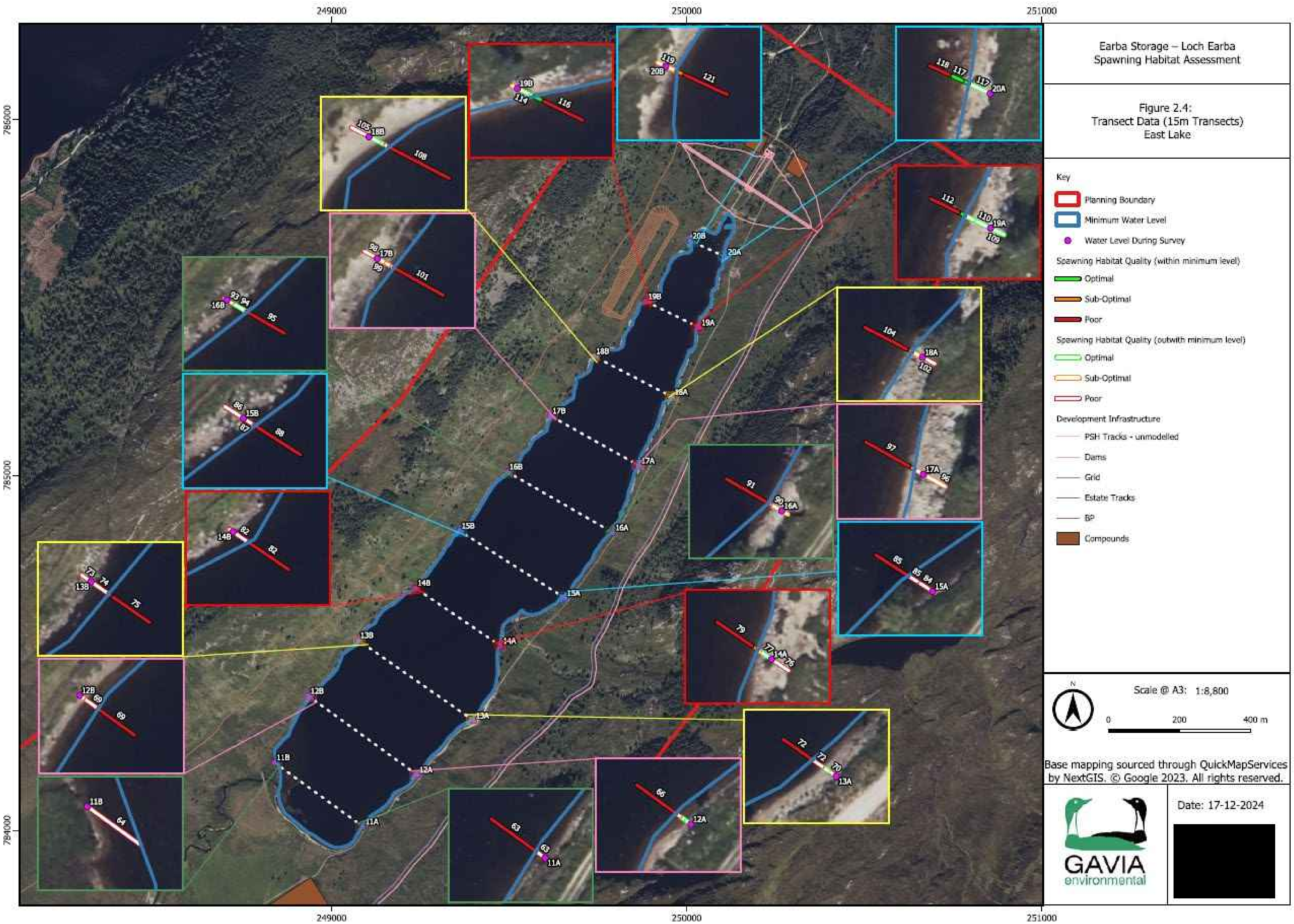
Earba Storage – Loch Earba
Spawning Habitat Assessment
Figure 2.4:
Transect Data (15m Transects)
East Lake
Key
Planning Boundary
Minimum Water Level
Water Level During Survey
Spawning Habitat Quality (within minimum level)
Optimal
Sub-Optimal
Poor
Spawning Habitat Quality (outwith minimum level)
Optimal
Sub-Optimal
Poor
Development Infrastructure
PSH Tracks - unmodelled
Dams
Grid
Estate Tracks
BP
Compounds
Scale @ A3: 1:8,800
0
200
400 m
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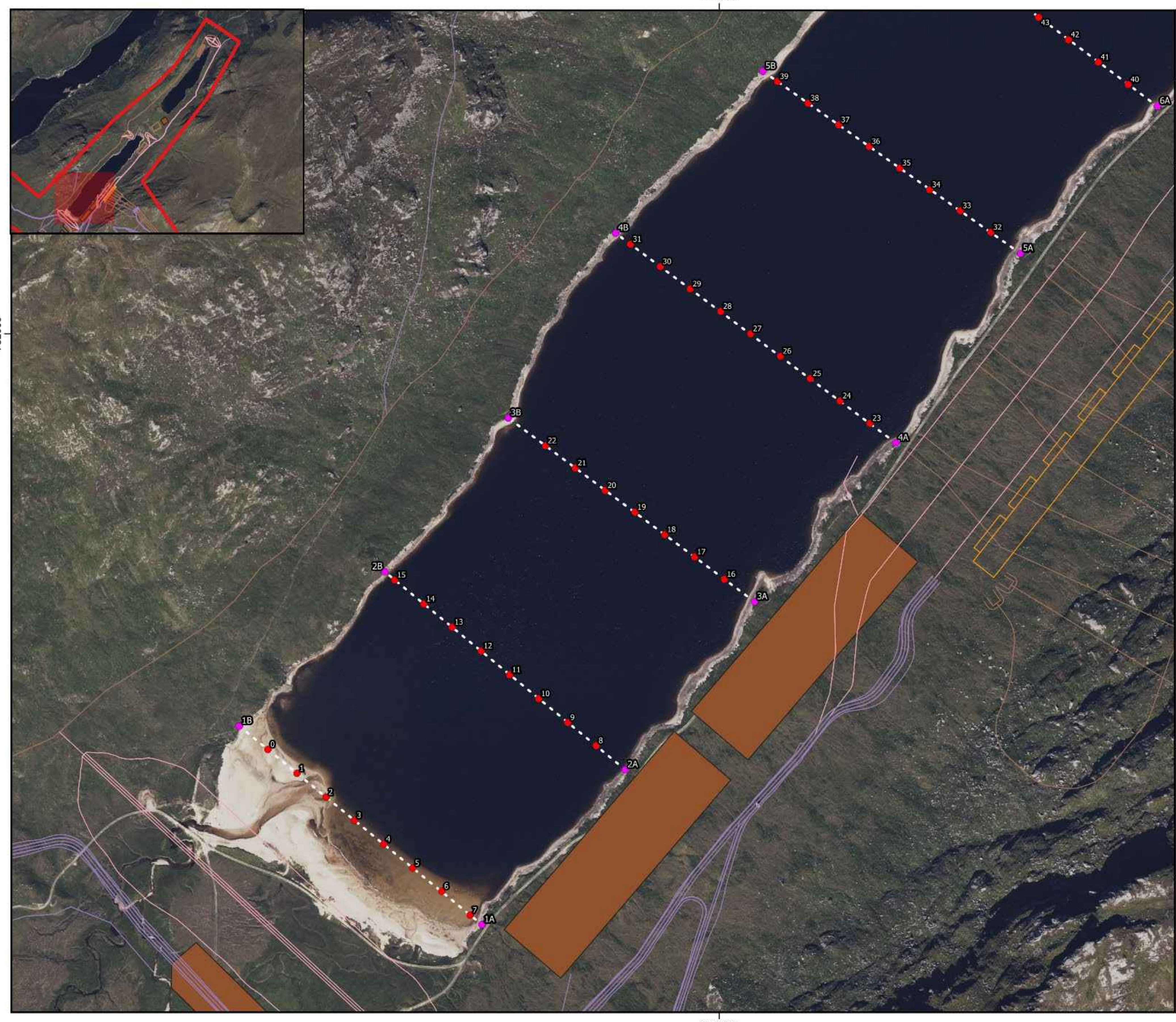
GAVIA
environmental
Date: 17-12-2024
[redacted]
249000
250000
251000
785000
784000
786000
11A
11B
12A
12B
13A
13B
14A
14B
15A
15B
16A
16B
17A
17B
18A
18B
19A
19B
20A
20B



Earba Storage – Loch Earba
Spawning Habitat Assessment

Figure 3.1:
Point Location Data
(50m Spot Checks)

Key

Planning Boundary

Spawning Habitat Assessment 2024

Water Level During Survey

Spawning Habitat Quality

Optimal

Sub-Optimal

Poor

Development Infrastructure

PSH Tracks - modelled

PSH Tracks - unmodelled

Powerhouse

Surge

Dams

Peninsula

Intake

Grid

Estate Tracks

Estate Footpaths

BP

Aqueduct and Diversion

Adit

Tunnel

Compounds

N

Scale @ A3: 1:4,800

0 100 200 m

GAVIA
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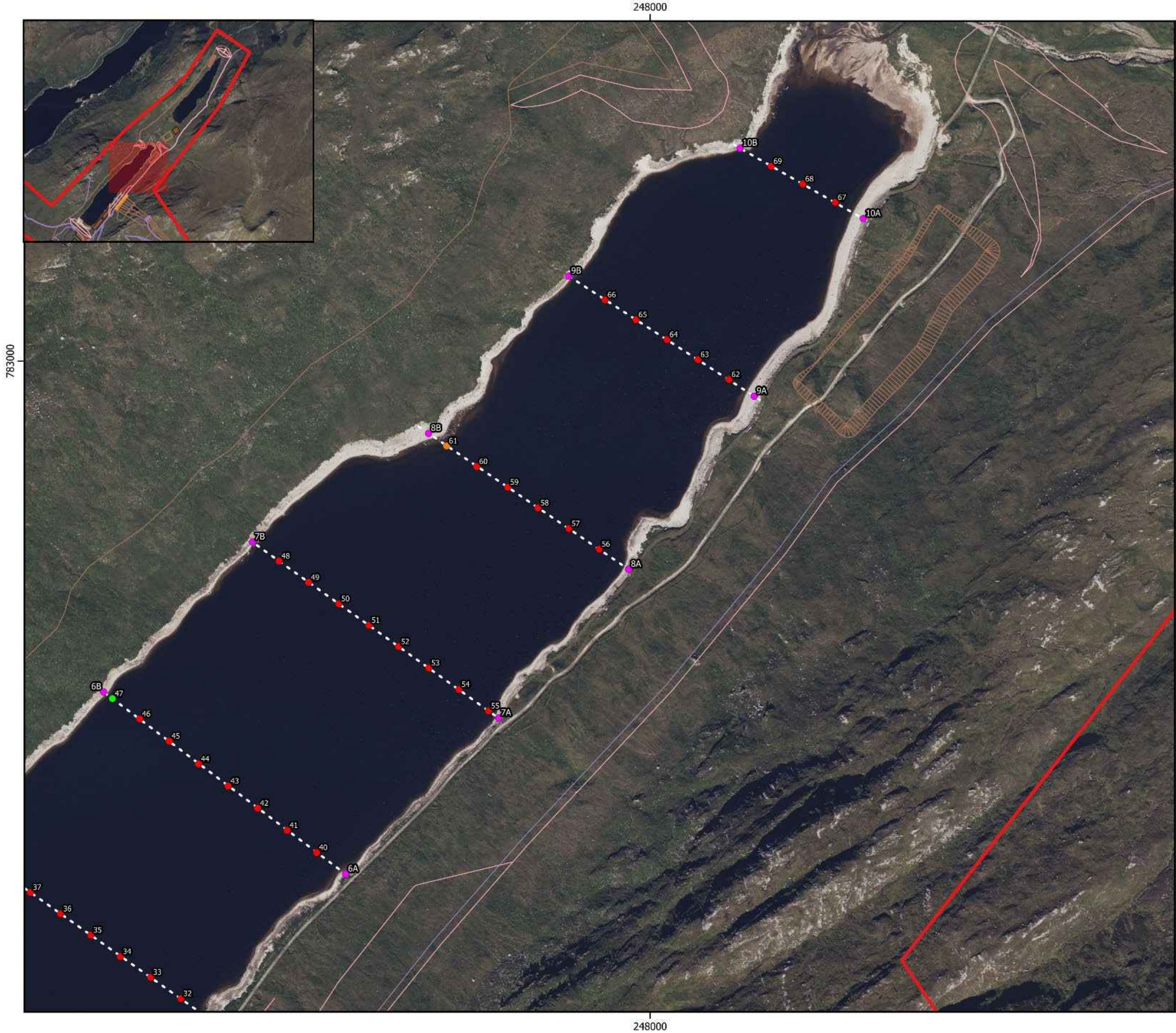
Date: 11-11-2024

[redacted]



Earba Storage – Loch Earba
Spawning Habitat Assessment

Figure 3.2:
Point Location Data
(50m Spot Checks)

Key

- Planning Boundary

Spawning Habitat Assessment 2024

- Water Level During Survey

Spawning Habitat Quality

- Optimal
- Sub-Optimal
- Poor

Development Infrastructure

- PSH Tracks - modelled
- PSH Tracks - unmodelled
- Powerhouse
- Surge
- Dams
- Peninsula
- Intake
- Grid
- Estate Tracks
- Estate Footpaths
- BP
- Aqueduct and Diversion
- Adit
- Tunnel
- Compounds

N

Scale @ A3: 1:4,800

0 100 200 m

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Date: 11-11-2024

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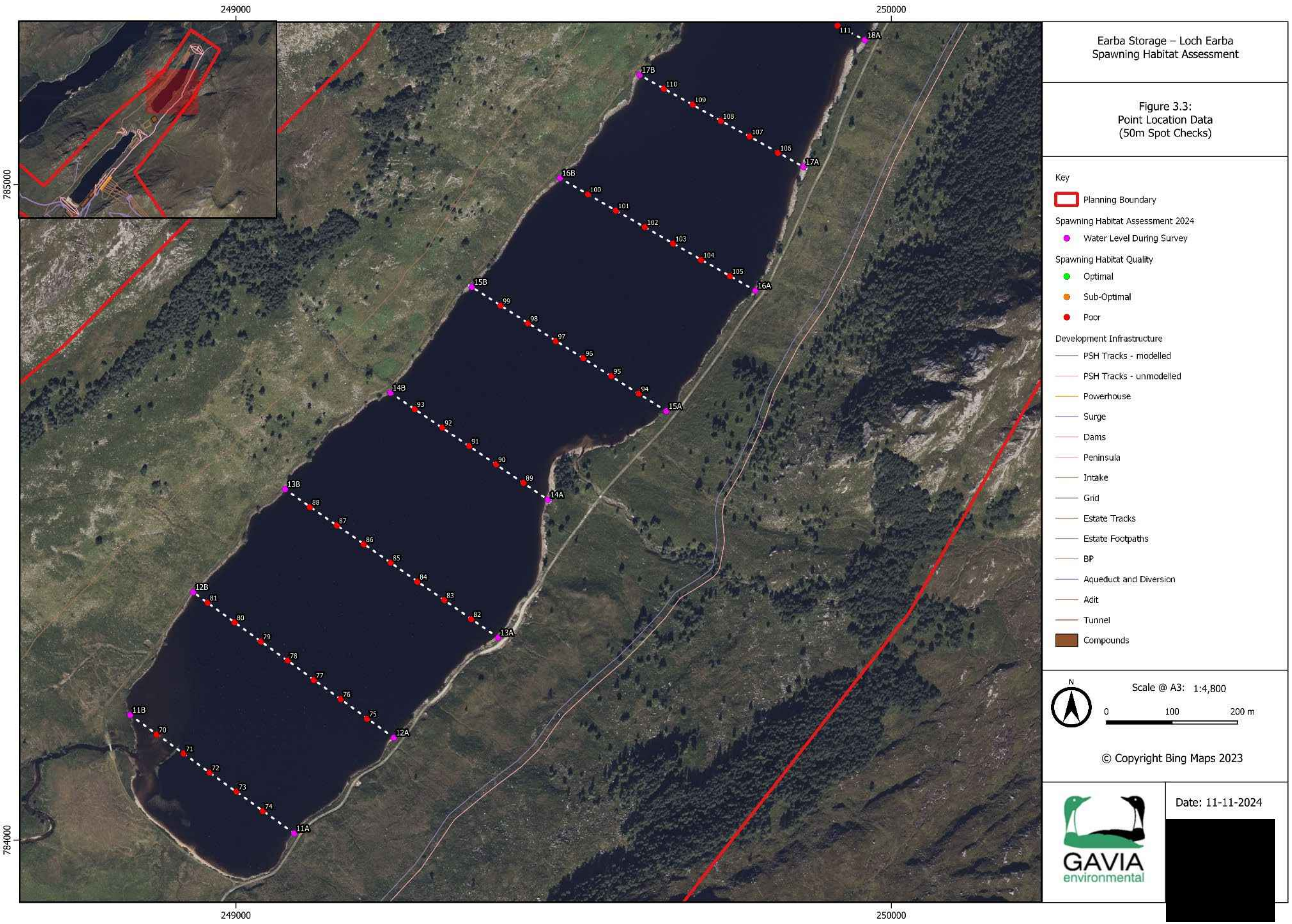

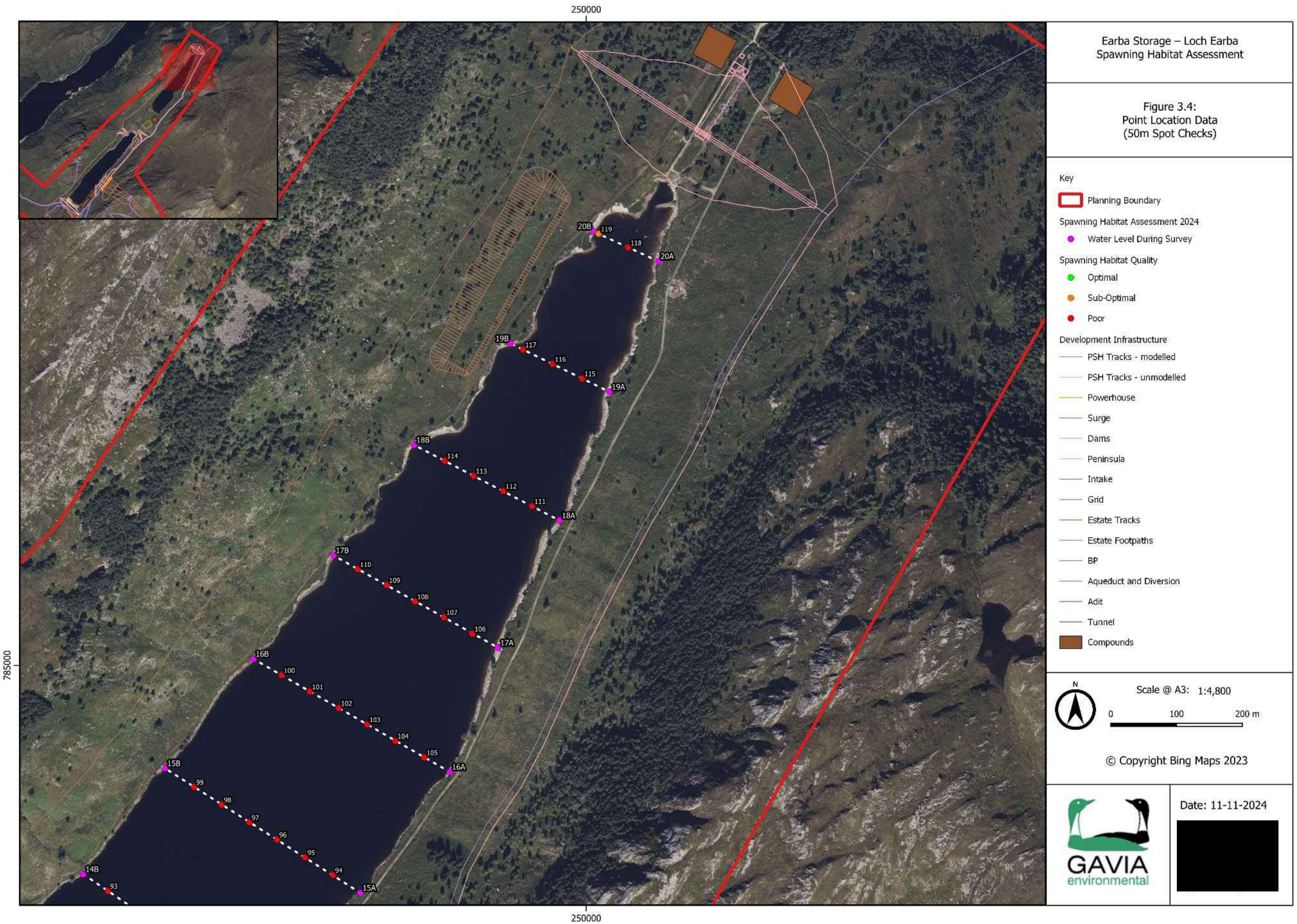
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785000
250000
20B
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118
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19B
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18B
114
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112
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17B
110
109
108
107
106
17A
16B
100
101
102
103
104
105
16A
15B
99
98
97
96
95
94
15A
14B
93
Earba Storage – Loch Earba
Spawning Habitat Assessment
Figure 3.4:
Point Location Data
(50m Spot Checks)
Key
Planning Boundary
Spawning Habitat Assessment 2024
Water Level During Survey
Spawning Habitat Quality
Optimal
Sub-Optimal
Poor
Development Infrastructure
PSH Tracks - modelled
PSH Tracks - unmodelled
Powerhouse
Surge
Dams
Peninsula
Intake
Grid
Estate Tracks
Estate Footpaths
BP
Aqueduct and Diversion
Adit
Tunnel
Compounds
N
Scale @ A3: 1:4,800
0
100
200 m
© Copyright Bing Maps 2023
GAVIA
environmental
Date: 11-11-2024
[redacted]

Appendix B Spawning Habitat Assessment Raw Field Data

Transect Data (15m Transects)

Table 4. Transect Data (15m Transects) raw data

Transect	ID	Habitat	Field Notes	% Organic Silt	% Sand	% Gravel	% Pebble	% Cobble	% Boulder	% Bedrock	Total	Macrophytes	Length (m)
1A	1	Poor	>60 plants rooted within sand	0	90	0	0	0	10	0	100	Yes	7
1A	2	Poor		0	90	0	0	0	10	0	100		8
1B	3	Poor	Sand with erratic boulders	0	95	0	0	0	5	0	100		15
2A	4	Poor	Changing into sand and macrophyte growth	30	60	0	5	5	0	0	100	Yes	5
2A	5	Poor	Looks to periodically be dry, terrestrial plants rooted into interstitial spaces	10	30	0	20	20	20	0	100		2
2A	6	Sub-Optimal	Lack of clean gravel so SO	0	20	5	10	40	25	0	100		8
2B	7	Poor	>60% macrophyte growth	60	30	0	10	0	0	0	100	Yes	11
2B	8	Poor	Boulder and looks to be normally dry	5	5	0	0	0	90	0	100		4
3A	9	Optimal	Optimal but may be prone to periodic drying	0	20	30	50	0	0	0	100		3
3A	10	Poor	Lack of gravels Macrophyte growth but <60%	0	60	10	30	0	0	0	100	Yes	4
3A	11	Poor	Lacking clean gravels, interstitial spaces taken up by plant roots	0	30	10	0	60	0	0	100	Yes	8
3B	12	Sub-Optimal	Looks to periodically dry out, limited clean gravel	0	10	10	0	50	30	0	100		3
3B	13	Optimal		0	20	30	20	30	0	0	100		7
3B	14	Optimal	Optimal but may be prone to periodic drying	0	20	30	30	20	0	0	100		5
4B	15	Poor	Lack of gravel	0	0	0	0	0	100	0	100		4
4B	16	Sub-Optimal	Lacks gravel, Looks to periodically dry out	0	0	0	20	30	50	0	100		2
4B	17	Poor		100	0	0	0	0	0	0	100		6
4B	18	Sub-Optimal	Lacks gravel	0	10	0	20	40	30	0	100		3
4A	19	Poor	Mud with some macrophyte growth	80	20	0	0	0	0	0	100	Yes	8
4A	20	Poor	Lack of clean gravels	0	40	0	20	30	10	0	100		7
5A	21	Optimal	Optimal but may be prone to periodic drying. Some terrestrial growth in the margins	0	20	20	30	30	0	0	100		8
5A	22	Optimal		0	20	40	20	20	0	0	100		7
5B	23	Poor	Periodically dries and is dominated by boulder	0	0	0	0	0	100	0	100		4
5B	24	Poor	>60% macrophyte growth	0	50	0	50	0	0	0	100	Yes	3
5B	25	Sub-Optimal	Sub optimal because periodically dries and limited clean gravel	0	30	20	30	10	10	0	100		10
6A	26	Poor	Dry	0	0	0	10	10	80	0	100		1
6A	27	Sub-Optimal	Some terrestrial growth as normally dry	0	5	55	20	15	5	0	100		2
6A	28	Poor		0	90	0	0	5	5	0	100		2
6A	29	Sub-Optimal	Mainly sand	0	70	20	0	10	0	0	100		4
6A	30	Poor		40	40	0	0	10	10	0	100	Yes	6
6B	31	Poor	Lack of clean gravels, looks to periodically dry out	0	10	0	0	40	50	0	100		8
6B	32	Optimal	Optimal but prone to periodic drying	0	30	20	10	20	20	0	100		5
6B	33	Optimal	PE GR CO	0	5	40	35	20	0	0	100		2
7A	34	Poor	Made ground BO	0	5	0	5	10	80	0	100		3
7A	35	Optimal	Optimal but prone to periodic drying	0	20	30	40	10	0	0	100		5
7A	36	Poor		0	100	0	0	0	0	0	100	Yes	8
7A	37	Optimal		0	20	30	40	10	0	0	100		2
7B	38	Poor		0	10	5	5	10	70	0	100		1

Transect	ID	Habitat	Field Notes	% Organic Silt	% Sand	% Gravel	% Pebble	% Cobble	% Boulder	% Bedrock	Total	Macrophytes	Length (m)
7B	39	Poor		0	5	10	25	50	10	0	100		4
7B	40	Optimal		0	10	30	40	10	10	0	100		7
7B	41	Poor		50	50	0	0	0	0	0	100	Yes	0
7B	42	Optimal	Optimal but may be prone to periodic drying	0	10	25	25	30	10	0	100		3
8A	43	Poor	Made ground dry boulders / terrestrial vegetation	0	0	5	5	10	80	0	100		2
8A	44	Optimal	Optimal but may be prone to periodic drying	0	0	10	20	60	10	0	100		3
8A	45	Optimal	Optimal but may be prone to periodic drying	0	20	20	50	10	0	0	100		4
8A	46	Poor		50	40	0	10	0	0	0	100	Yes	6
8B	47	Poor		0	20	10	10	30	30	0	100		20
8B	48	Optimal	Optimal but may be prone to periodic drying	0	10	40	20	15	15	0	100		10
8B	49	Optimal		0	30	20	20	20	10	0	100		4
9A	50	Poor	Dry shore	0	5	0	10	10	75	0	100		9
9A	51	Sub-Optimal	More sand than gravel	0	50	10	30	10	0	0	100		12
9A	52	Poor		60	40	0	0	0	0	0	100	Yes	3
9B	53	Poor	Limited clean gravel and looks to periodically dry out	0	15	15	0	0	70	0	100		5
9B	54	Optimal	Optimal but may be prone to periodic drying	0	20	30	50	0	0	0	100		4
9B	55	Poor		60	40	0	0	0	0	0	100	Yes	11
10A	56	Sub-Optimal	Dry	0	10	5	0	10	75	0	100		5
10A	57	Optimal	Optimal but may be prone to periodic drying	0	10	30	30	30	0	0	100		15
10A	58	Optimal		0	30	50	0	0	20	0	100		3
10B	59	Poor	Dry and steep gradient	0	10	0	10	10	70	0	100		13
10B	60	Optimal		0	20	20	20	10	30	0	100		11
10B	61	Poor	Soft sand / mud some macrophyte	50	40	10	0	0	0	0	100	Yes	4
11A	62	Poor	Boulder with terrestrial plants	10	0	0	0	0	90	0	100	Yes	1
11A	63	Poor	Over 60% macrophyte cover on mud	60	20	0	0	10	10	0	100	Yes	15
11B	64	Poor	Peat going into mud and macrophyte growth	100	0	0	0	0	0	0	100	Yes	15
12A	65	Optimal		0	15	25	25	5	30	0	100		2
12A	66	Poor	Macrophyte growth and mud smothering substrate	60	0	0	10	30	0	0	100	Yes	12
12A	67	Optimal	Optimal but may be prone to periodic drying	0	10	20	20	0	50	0	100		1
12B	68	Sub-Optimal	Some flooded terrestrial plants	0	20	20	40	20	0	0	100		2
12B	69	Poor		70	10	0	10	10	0	0	100	Yes	13
13A	70	Poor	Dominated by boulder and terrestrial plant growth, steep gradient and dry at time of survey	0	0	0	0	0	100	0	100		2
13A	71	Optimal	Optimal but may be prone to periodic drying	0	30	20	40	10	0	0	100		2
13A	72	Poor	Macrophyte growth on sand	10	70	0	10	10	0	0	100	Yes	11
13B	73	Poor	Steep and dominated by boulder	0	0	0	0	0	100	0	100		3
13B	74	Poor	Dominated by sand and 60% macrophyte growth	0	80	0	0	10	10	0	100		6
13B	75	Poor	Dominated by macrophyte growth >60%	90	10	0	0	0	0	0	100	Yes	10
14A	76	Poor	Dry at time of survey, terrestrial plant growth in amongst substrate	30	10	0	40	20	0	0	100	Yes	5
14A	77	Optimal	Optimal but may be prone to periodic drying	0	10	10	40	20	20	0	100		3
14A	78	Sub-Optimal	>60% macrophyte growth but good availability of gravels and pebbles	0	30	30	40	0	0	0	100	Yes <60%	2
14A	79	Poor	>60% macrophyte growth covering bed	50	20	0	10	20	0	0	100	Yes	10
14B	80	Poor	Dry at time of survey	0	0	0	0	0	100	0	100		1
14B	81	Poor	Boulder dominated	0	0	0	0	0	100	0	100		1
14B	82	Poor	>60% macrophyte cover	20	50	0	10	10	10	0	100	Yes	15

Transect	ID	Habitat	Field Notes	% Organic Silt	% Sand	% Gravel	% Pebble	% Cobble	% Boulder	% Bedrock	Total	Macrophytes	Length (m)
15A	83	Sub-Optimal	Dry and lack of clean gravel	0	10	0	40	50	0	0	100		1
15A	84	Poor	>60% macrophyte cover	10	80	0	0	10	0	0	100	Yes	4
15A	85	Poor	>60% macrophyte cover	40	40	0	0	10	10	0	100	Yes	11
15B	86	Poor	Always dry	0	0	0	0	5	90	5	100		5
15B	87	Poor	No clean gravels, all larger substrate	0	0	0	0	40	40	20	100		3
15B	88	Poor	Steep drop off into muddy bottom with macrophyte growth	50	20	0	15	5	10	0	100	Yes	12
16A	89	Sub-Optimal	Dry at time of survey	0	20	40	30	5	5	0	100		2
16A	90	Sub-Optimal	Lack of gravel	0	30	0	20	40	10	0	100		3
16A	91	Poor	>60% macrophyte growth and organic matter amongst stones	40	40	0	5	10	5	0	100	Yes	12
16B	92	Poor	BO dominant	0	0	0	0	0	100	0	100		1
16B	93	Poor		0	10	0	0	0	90	0	100		2
16B	94	Optimal		0	10	20	0	10	60	0	100		3
16B	95	Poor	Macrophyte growth clogging up interstitial spaces	20	10	5	10	40	15	0	100	Yes	10
17A	96	Sub-Optimal	Dry at time of survey	0	5	35	30	30	0	0	100		9
17A	97	Poor	Some macrophyte beds on sand	0	80	0	10	10	0	0	100	Yes	11
17B	98	Poor	Looks to always be dry	10	0	0	30	30	30	0	100		3
17B	99	Sub-Optimal	Limited gravel and dry at time of survey	0	5	5	30	30	30	0	100		2
17B	100	Sub-Optimal	Limited clean gravel	0	45	5	20	20	10	0	100		1
17B	101	Poor	Carpeted in macrophytes >80%	80	0	0	0	10	10	0	100	Yes	13
18A	102	Poor	Dry at bankside and terrestrial plants in interstitial spaces	0	10	10	30	20	30	0	100		3
18A	103	Sub-Optimal		0	20	25	5	25	25	0	100		4
18A	104	Poor	Macrophyte growth	0	80	0	0	10	10	0	100	Yes	11
18B	105	Poor	Looks to be always dry	0	10	5	5	80	0	0	100		3
18B	106	Optimal		0	20	20	60	0	0	0	100		1
18B	107	Optimal	Optimal but may be prone to periodic drying	0	20	20	60	0	0	0	100		2
18B	108	Poor	Muddy bottom and macrophyte growth	60	10	0	30	0	0	0	100	Yes	12
19A	109	Optimal	Optimal but may be prone to periodic drying	0	10	80	0	0	10	0	100		3
19A	110	Optimal	Optimal but may be prone to periodic drying	0	20	50	10	10	10	0	100		4
19A	111	Optimal		0	10	30	50	10	0	0	100		4
19A	112	Poor	Macrophyte growth	10	70	0	20	0	0	0	100	Yes	7
19B	113	Sub-Optimal	Dry at time of survey	0	30	20	30	20	0	0	100		1
19B	114	Optimal	Optimal but may be prone to periodic drying	0	20	50	20	10	0	0	100		3
19B	115	Optimal		0	0	60	20	10	10	0	100		3
19B	116	Poor	>60% Macrophyte cover in interstitial spaces	10	20	0	30	40	0	0	100	Yes	9
20A	117	Optimal	Optimal but may be prone to periodic drying, less protection with mainly gravel	0	20	60	0	10	10	0	100		7
20A	118	Poor	Macrophyte cover over 60% in places	0	70	5	5	10	10	0	100	Yes	5
20B	119	Sub-Optimal	Dry at time of survey	0	35	40	10	10	5	0	100		5
20B	120	Sub-Optimal	Rooting of macrophytes in interstitial spaces and substrate not clean	15	15	10	20	20	20	0	100	Yes	2
20B	121	Poor	Algal covering of substrate, macrophytes rooted in between boulder	15	0	0	10	30	45	0	100	Yes	11

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Point Location Data (50m Spot Checks)

Table 5. Point Location Data (50m Spot Checks) raw data

Transect	ID	Easting	Northing	Depth (m)	Habitat	% Boulder	% Cobble	% Pebble	% Gravel	% Sand	% Organic Silt	% Bedrock
1	0	246395	781443	1.0	Poor	0	0	0	0	100	0	0
1	1	246434	781411	1.2	Poor	0	0	0	0	100	0	0
1	2	246473	781379	1.5	Poor	0	0	0	0	100	0	0
1	3	246511	781348	2.0	Poor	0	0	0	0	100	0	0
1	4	246550	781316	1.9	Poor	0	0	0	0	100	0	0
1	5	246589	781284	1.8	Poor	0	0	0	0	100	0	0
1	6	246628	781253	1.7	Poor	0	0	0	0	100	0	0
1	7	246666	781221	1.6	Poor	0	0	0	0	100	0	0
2	8	246835	781448	7.6	Poor	0	0	0	0	100	0	0
2	9	246797	781479	8.2	Poor	0	0	0	0	50	50	0
2	10	246758	781511	9.6	Poor	0	0	0	0	50	50	0
2	11	246719	781543	11.7	Poor	0	0	0	0	50	50	0
2	12	246681	781575	11.7	Poor	0	0	0	0	50	50	0
2	13	246642	781607	11.7	Poor	0	0	0	0	50	50	0
2	14	246604	781638	8.3	Poor	0	0	0	0	50	50	0
2	15	246565	781670	2.8	Poor	0	0	0	0	50	50	0
3	16	247007	781671	4	Poor	0	0	0	0	50	50	0
3	17	246967	781701	9.4	Poor	0	0	0	0	50	50	0
3	18	246927	781731	14.8	Poor	0	0	0	0	50	50	0
3	19	246887	781761	15.6	Poor	0	0	0	0	50	50	0
3	20	246847	781790	13.9	Poor	0	0	0	0	50	50	0
3	21	246807	781820	9.8	Poor	0	0	0	0	50	50	0
3	22	246767	781850	9.3	Poor	0	0	0	0	50	50	0
4	23	247202	781880	6.7	Poor	0	0	0	5	50	45	0
4	24	247162	781910	11	Poor	0	0	0	0	50	50	0
4	25	247122	781940	15.4	Poor	0	0	0	0	50	50	0
4	26	247082	781970	18.6	Poor	0	0	0	0	50	50	0
4	27	247042	782000	19.9	Poor	0	0	0	0	50	50	0
4	28	247002	782030	18.3	Poor	0	0	0	0	50	50	0
4	29	246961	782060	15.8	Poor	0	0	0	0	50	50	0
4	30	246921	782090	11.4	Poor	0	0	0	0	50	50	0
4	31	246881	782120	7.1	Poor	0	0	10	0	0	90	0
5	32	247364	782136	10.5	Poor	0	0	0	0	0	100	0
5	33	247323	782165	15.3	Poor	0	0	0	0	0	100	0
5	34	247282	782193	17.8	Poor	0	0	0	0	0	100	0
5	35	247242	782222	20.7	Poor	0	0	0	0	10	90	0
5	36	247201	782251	21.1	Poor	0	0	0	0	0	100	0
5	37	247160	782280	19.9	Poor	0	0	0	0	0	100	0
5	38	247119	782309	15.2	Poor	0	0	0	0	0	100	0
5	39	247078	782338	5.2	Poor	0	0	0	0	0	100	0
6	40	247548	782334	8.8	Poor	0	0	0	10	0	90	0
6	41	247508	782364	16.6	Poor	0	0	0	0	0	100	0
6	42	247468	782394	22.1	Poor	0	0	0	0	0	100	0

Transect	ID	Easting	Northing	Depth (m)	Habitat	% Boulder	% Cobble	% Pebble	% Gravel	% Sand	% Organic Silt	% Bedrock
6	43	247428	782424	24.4	Poor	0	0	0	0	0	100	0
6	44	247388	782454	22.4	Poor	0	0	0	0	0	100	0
6	45	247348	782485	21.7	Poor	0	0	0	0	0	100	0
6	46	247308	782515	20.1	Poor	0	0	0	0	0	100	0
6	47	247268	782545	1.5	Optimal	0	10	30	40	20	0	0
7	48	247497	782729	5	Poor	0	0	5	0	0	95	0
7	49	247537	782700	11.4	Poor	0	0	0	0	0	100	0
7	50	247578	782671	15.8	Poor	0	0	0	0	0	100	0
7	51	247619	782642	23.2	Poor	0	0	0	0	0	100	0
7	52	247659	782613	24.1	Poor	0	0	0	0	0	100	0
7	53	247700	782584	20.4	Poor	0	0	0	0	0	100	0
7	54	247741	782555	11.3	Poor	0	0	0	0	0	100	0
7	55	247781	782526	2.8	Poor	0	0	0	0	0	100	0
8	56	247931	782745	13.3	Poor	0	0	0	0	0	100	0
8	57	247890	782773	17.9	Poor	0	0	0	0	0	100	0
8	58	247848	782801	22.6	Poor	0	0	0	0	0	100	0
8	59	247807	782829	16.5	Poor	0	0	0	0	0	100	0
8	60	247765	782857	6.7	Poor	0	0	0	0	0	100	0
8	61	247724	782885	1.2	Sub-Optimal	10	0	50	10	30	0	0
9	62	248107	782975	12.5	Poor	0	0	0	0	0	100	0
9	63	248065	783002	18.8	Poor	0	0	0	0	0	100	0
9	64	248023	783029	18.2	Poor	0	0	0	0	0	100	0
9	65	247981	783056	5.2	Poor	0	0	0	0	0	100	0
9	66	247939	783083	6.7	Poor	0	0	0	0	0	100	0
10	67	248251	783215	6.2	Poor	0	0	0	0	0	100	0
10	68	248207	783240	11.5	Poor	0	0	0	0	0	100	0
10	69	248164	783264	7	Poor	0	0	0	0	0	100	0
11	70	248879	784161	0.4	Poor	0	0	0	0	0	100	0
11	71	248920	784132	5.5	Poor	0	0	0	0	0	100	0
11	72	248960	784103	9.1	Poor	0	0	0	0	0	100	0
11	73	249001	784074	10.1	Poor	0	0	0	0	0	100	0
11	74	249041	784044	5.6	Poor	0	0	0	0	0	100	0
12	75	249200	784185	9.1	Poor	0	0	0	0	0	100	0
12	76	249160	784215	16.9	Poor	0	0	0	0	0	100	0
12	77	249119	784244	21.7	Poor	0	0	0	0	0	100	0
12	78	249079	784274	20.7	Poor	0	0	0	0	0	100	0
12	79	249038	784303	14.9	Poor	0	0	0	0	0	100	0
12	80	248998	784332	11.5	Poor	0	0	0	0	0	100	0
12	81	248957	784362	3.6	Poor	0	0	0	0	0	100	0
13	82	249359	784337	5.9	Poor	0	0	0	0	0	100	0
13	83	249318	784366	16	Poor	0	0	0	0	0	100	0
13	84	249277	784394	21.1	Poor	0	0	0	0	0	100	0
13	85	249236	784423	18.8	Poor	0	0	0	0	0	100	0
13	86	249195	784451	19.8	Poor	0	0	0	0	0	100	0
13	87	249154	784480	18.7	Poor	0	0	0	0	0	100	0

Transect	ID	Easting	Northing	Depth (m)	Habitat	% Boulder	% Cobble	% Pebble	% Gravel	% Sand	% Organic Silt	% Bedrock
13	88	249113	784508	8.8	Poor	0	0	0	0	0	100	0
14	89	249439	784545	5.9	Poor	0	0	0	0	50	50	0
14	90	249397	784573	16.8	Poor	0	0	0	0	0	100	0
14	91	249356	784601	14.2	Poor	0	0	0	0	0	100	0
14	92	249315	784629	15.1	Poor	0	0	0	0	0	100	0
14	93	249273	784657	12.4	Poor	0	0	0	0	0	100	0
15	94	249615	784681	13.6	Poor	0	0	0	0	0	100	0
15	95	249573	784708	15.8	Poor	0	0	0	0	0	100	0
15	96	249530	784735	19.5	Poor	0	0	0	0	0	100	0
15	97	249488	784761	16.8	Poor	0	0	0	0	0	100	0
15	98	249446	784788	15.7	Poor	0	0	0	0	0	100	0
15	99	249404	784815	13.5	Poor	0	0	0	0	0	100	0
16	100	249537	784985	9.6	Poor	0	0	0	0	50	50	0
16	101	249580	784960	13.1	Poor	0	0	0	0	0	100	0
16	102	249624	784935	16.2	Poor	0	0	0	0	0	100	0
16	103	249667	784910	18.5	Poor	0	0	0	0	0	100	0
16	104	249710	784885	18.5	Poor	0	0	0	0	0	100	0
16	105	249754	784860	14.9	Poor	0	0	0	0	0	100	0
17	106	249827	785048	4.0	Poor	0	0	0	0	0	100	0
17	107	249784	785073	4.8	Poor	0	0	0	0	0	100	0
17	108	249740	785097	4.9	Poor	0	0	0	0	0	100	0
17	109	249697	785122	4.8	Poor	0	0	0	0	0	100	0
17	110	249653	785146	4.0	Poor	0	0	0	0	0	100	0
18	111	249918	785242	3.9	Poor	0	0	0	0	0	100	0
18	112	249874	785265	4.4	Poor	0	0	0	0	0	100	0
18	113	249829	785288	4.3	Poor	0	0	0	0	0	100	0
18	114	249785	785311	3.4	Poor	0	0	0	0	0	100	0
19	115	249994	785436	3.1	Poor	0	0	0	0	0	100	0
19	116	249949	785458	3.4	Poor	0	0	0	0	0	100	0
19	117	249904	785480	1.3	Poor	0	0	0	0	0	100	0
20	118	250064	785635	1.9	Poor	0	10	10	0	40	40	0
20	119	250019	785656	0.7	Sub-Optimal	0	60	20	0	20	0	0

Appendix C Photographs

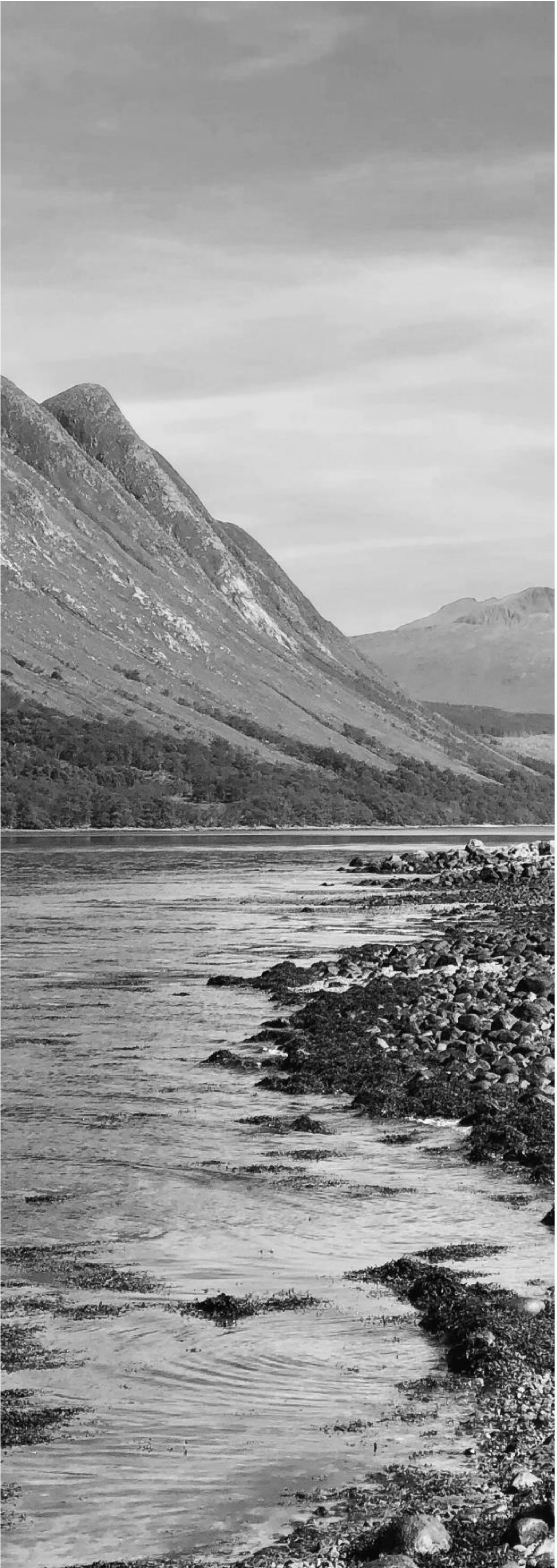
Plate Number	Description	Photograph
15m Transects		
1	'Optimal' spawning habitat recorded at 15m transect 8B. Clean gravels with protection from some larger pebble and cobble substrate.	
2	'Optimal' substrate with clean gravels with protection from larger pebble and cobble. There is a likelihood that this area periodically dries out – following review of aerial mapping (Bing Maps). Recorded at 15m transect 7A.	

Plate Number	Description	Photograph
3	'Poor' spawning habitat recorded at 15m transect 11A with thick beds of aquatic macrophytes including *Myriophyllum alterniflorum* rooted to the bed	
5	'Poor' spawning habitat recorded at 15m transect 12A with a lack of clean gravel, organic material smothering larger substrate and some aquatic macrophytes rooted between stones.	
Point Location Transects		
4	Uniform 'poor' habitat featured predominantly across open water. This was recorded as either sand or organic silt (Point Location Transect 15).	

Plate Number	Description	Photograph
5	Point Locations - Evidence of the soft sediment pulsing up when the camera hits the loch bed. (The camera is angled on its side in this picture).	
6	'Sub-optimal' substrate with limited gravels but some pebble and cobble. <60% macrophyte growth was recorded at this location which may impact on spawning beds. Recorded at Point Location - transect 20 (ID 119)	
7	Optimal substrate with clean gravels with protection from larger pebble and cobble. This was the only point location recorded as 'optimal'. Recorded at Point Location Transect 6 (ID 47)	

Other		
10	Loch Earba west basin water level was high during the survey with the loch level almost flooded up to the bank in places. This was following recent heavy rain and the effect of the hydro dam (right) between the two lochs.	 
11	Loch Earba east basin was also relatively high with areas identified as dry on the aerial mapping (Bing Maps) inundated at the time of survey.	

Appendix F Earba Fish Population Assessment (2024)



EARBA PUMPED STORAGE HYDROSCHEME

FISH POPULATION ASSESSMENT

EARBA LTD.

19/12/2024

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Project number P24267

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Revision History

Revision	Date	Prepared By	Reviewed By	Approved By	Comments
V0.1	20/09/2024	[redacted]			
V1.0	01/11/2024				
V1.1	16/12/2024				Revisions following client comment

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 Earba Pumped Storage Hydroscheme, 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.

GAVIA environmental

Contents

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Executive Summary

Gavia Environmental Ltd. was commissioned by Earba Ltd. (hereafter 'The Client') to undertake a fish population assessment using electrofishing techniques on watercourses flowing into Lochan na h-Earba (hereafter referred to as Loch Earba) in relation to the proposed Earba Pumped Storage Hydroscheme (PSH).

Assessment of the species composition, abundance and age class structure of fish fauna was carried out in accordance with SFCC guidelines on undertaking and managing electrofishing operations (SFCC, 2007) and British Standards BS 14011 (sampling of fish with electricity) and BS 14962 (guidance on the scope and selection of fish sampling methods). A fully quantitative survey methodology was employed.

Fish densities have been assessed using two distinct methods, as follows.

Firstly, species data collected from fully quantitative survey methods were assessed using a statistical model to identify a fully quantitative population estimate for each survey location. Fish densities were expressed as fish per 100 m^2, and densities were presented separately for fry (0+, young of the year) and parr (1++, fish older than 1 year). The statistical model used for relevant population estimation was Removal Sampling 2 (Seaby and Henderson, 2008). Where densities are low and small quantities of fish are captured, fully quantitative estimates are often unable to be established. Where this was the case, densities are expressed as a minimum estimate of fry or parr per 100 m^2.

Secondly, fish densities have also been expressed in a regional context. SFCC regional classifications are based on single-run electrofishing events rather than fully quantitative sampling (density based on number of fish captured during a single electrofishing run at each survey location). The result of only the first run of fully-quantitative electrofishing survey is applied to enable SFCC regional classification. The classifications are based on data sets held by SFCC. The data held for the West Region allows the fish abundance to be analysed in a regional context. Different classifications are provided for different stream widths. The classifications presented in this report are based on stream widths of less than 4 m (EA3 & EA5) and between 4-6 m (EA1, EA2 & EA6). The SFCC single-run classification methodology produces a result with a lower level of precision than that required to inform a full Environmental Impact Assessment (EIA), where baseline information on fish populations prior to the development will need to be collected, often for a number of years. When providing information for EIAs the SFCC recommends that fully quantitative sampling is performed.

This report provides fully-quantitative population data where sample sizes allowed. SFCC classifications are also provided as a useful analysis in a regional context.

In total, two fish species were identified during electrofishing surveys: Brown trout and Eurasian minnow. No Arctic charr were identified during the 2024 electrofishing survey. Brown trout fry (0+) were present at survey locations EA1 and EA6. Brown trout parr (1++) were present at all survey locations (EA2, EA3, EA5 and EA6) but absent from EA1, possibly due to a lack of bankside cover and large substrate which provides instream cover for larger fish.

Fully quantitative population estimates for brown trout fry (0+) ranged from 6.1 / 100m^2 (EA3) to 58 / 100m^2 (EA5). For brown trout parr (1++), most densities captured were low therefore some of the results could not be applied to the statistical depletion model (EA1, EA3 & EA5). These densities are expressed as a minimum estimate. Fully quantitative density estimates for brown trout parr ranged from 4.2 / 100 m^2 (EA2) – 8.3 / 100 m^2 (EA6). Including minimum density estimates, densities ranged from absent (EA1) to 8.3 / 100 m^2 (EA6).

SFCC regional classification scheme ratings for Brown trout fry ranged from *Very Poor (EA3)* to *Poor* (EA5) to *Moderate* (EA1 & EA6) to *Good* (EA2) and for Brown trout parr ranged from *Absent* (EA1) to *Very Poor* (EA3 and EA5) to *Poor* (EA2 & EA6). Stream width has a significant bearing on the SFCC classification, with stream widths of <4 m requiring much higher

densities to achieve Moderate / Good / Excellent classification status respectively than stream widths of 4-6 m.

The fish population survey results act as a baseline to which future years' survey results can be compared.

1 Introduction

Gavia Environmental Ltd. was commissioned by Earba Ltd. (hereafter 'The Client') to undertake a fish population assessment using electrofishing techniques on watercourses flowing into Lochan na h-Earba (hereafter referred to as Loch Earba) in relation to the proposed Earba Pumped Storage Hydro scheme (PSH). Although Loch Earba is considered to be one waterbody, it is considered to have two basins (separated by a river and dam) hereafter referred to as Loch Earba East (approximate grid reference NN 49477 84783) and Loch Earba West (approximate grid reference NN 47315 82322).

This document has been compiled as an addendum to the Aquatic Technical Appendix which was issued in February 2024 to inform a SEPA Controlled Activities Regulations (CAR) licence application.

1.1 Background

The client is proposing to construct a new long-scale, long duration 1800 MW pumped storage hydro scheme and associated infrastructure on Loch Earba and 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) and some riverine habitat will be affected by the construction of the dams as shown in **Appendix A, 'Proposed Development'**. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

1.2 Discussion with SEPA

SEPA was consulted on the proposed aquatic surveys and the methodologies employed.

Additional surveys were requested by SEPA and included a fish population assessment using electrofishing techniques.

Previous surveys undertaken in 2023 took place early in the electrofishing season (early July), consequently, Brown trout and Arctic charr *Salvelinus alpinus* fry could not adequately be identified to species level. It was proposed that further fully-quantitative electrofishing surveys are carried out in mid to late August in 2024. Re-surveying later in the season should allow for identification of fry to species level and allow population calculations to be made.

A photographic record of each fish was retained for external verification by [redacted] of Glasgow University (Professor of Freshwater Ecology), an author of numerous scientific research papers on Arctic charr.

1.3 Licencing

Electrofishing was conducted under a Marine Scotland issued Licence (Application Reference CSM-24-034).

1.4 Survey dates

Dates surveys were conducted on are provided in **Table 1**.

Table 1. Survey Dates

Field Survey	Survey Dates	Surveyors
Electrofishing surveys	15th – 16th August 2024	[redacted]

2 Methodology

2.1 Field Surveys

2.1.1 Fish Population Assessment (Electrofishing)

Electrofishing was conducted at five locations where fish habitat was assessed to be of suitable quality to support salmonids during the initial habitat walkover surveys. These are the same survey locations as surveyed in 2023, with the semi quantitative / timed sites (EA7, EA8, EA9) and EA4 (Allt Loch a' Bhealaich Leamhain) omitted from the assessment with SEPA agreement. All surveys were conducted within the Red Line Boundary where relevant landownership was attained. Survey locations are provided in **Table 2**.

Table 2. Electrofishing Survey Locations

Survey Location	Easting	Northing	Survey Type
EF1	248466	783751	Fully-quantitative
EF2	248475	783444	Fully-quantitative
EF3	246237	781277	Fully-quantitative
EF5	249556	784520	Fully-quantitative
EF6	246405	780832	Fully-quantitative

Assessment of the species composition, abundance and age class structure of fish fauna was carried out in accordance with SFCC guidelines on undertaking and managing electrofishing operations (SFCC, 2007) and British Standards BS 14011 (sampling of fish with electricity) and BS 14962 (guidance on the scope and selection of fish sampling methods) within fully-quantitative surveys.

All works were administered under Marine Scotland Licence (issued in line with the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 – Sections 27 & 28) and all terms and conditions were adhered to.

Before any fish fauna sampling was carried out, specific risk assessments were prepared and followed during the works. The risk assessments covered other issues such as fish handling protocols for minimising stress, proper use of equipment to minimise potential for damage to fish and other species, biosecurity protocols for disinfection of nets/equipment and species likely to be present.

Electrofishing surveys were carried out during mid-August 2024. This is within the optimal time of year for survey as salmonid young of year have emerged from spawning redds and reached a sufficient size to be safely captured and identified to species level. Water temperatures will also generally be within the optimal range for capture by electrofishing (10 – 15 ◦C).

The survey team comprised three experienced surveyors. The survey lead was qualified to SVQ Level III (leading electrofishing operations). The first assistant was qualified to SVQ Level II (introduction to electrofishing) and the second assistant was experienced in fieldwork operations. The surveys were undertaken using a Hans Grassl Electrofishing kit which is battery powered and was set up to drive a single anode. Smooth DC current was utilised as this is generally accepted as the least damaging to fish during this type of survey.

Fully-quantitative sampling was the preferred methodology for all sites as it allows for enumeration of a stock, or stock component, within a given site and provides a reasonably accurate estimate of a given population.

Individuals caught were carefully placed in an aerated freshwater container with a small hand net. Individuals were anaesthetised using 5 ml^{-1} benzocaine solution and their fork length (mm) recorded. Each fish was photographed for reference. All individuals were released at the upstream limit of the survey location post-processing.

2.1.2 Analysis

Species data collected from fully-quantitative survey methods were assessed using a statistical model to identify a population estimate for each survey location. Fish densities were expressed as fish per 100 m^2, and densities were presented separately for fry (0+, young of the year) and parr (1++, fish older than 1 year). The statistical model used for relevant population estimation was Removal Sampling 2 (Seaby and Henderson, 2008), and this was linked to the following method: Constant probability of capture – developed by Zippin (1956). This method takes into account the likelihood that the capture of different individuals within a population is constant. The calculation of the estimated population uses maximum likelihood estimates. The model is less accurate when dealing with low densities of fish. Some brown trout parr densities were so low (i.e. only one or two fish captured) that fully quantitative estimates were unable to be established. Where this was the case, densities are expressed as a minimum estimate of fry or parr per 100 m^2.

<u>SFCC Classification Scheme</u>

The Scottish Fisheries Coordination Centre (SFCC) developed a national river classification scheme for Scottish rivers (Godfrey, 2005). The SFCC classification is based on single-run electrofishing events rather than fully-quantitative sampling (density based on number of fish captured during a single electrofishing run at each survey location). The result of only the first run of fully-quantitative electrofishing survey is applied to enable SFCC regional classification. The classifications are based on data sets held by SFCC. The data held for the West Region allows the fish abundance to be analysed in a regional context. Different classifications are provided for different stream widths. The classifications presented in this report are based on stream widths of less than 4 m (EA3 & EA5) and between 4-6 m (EA1, EA2 & EA6).

The SFCC single-run classification methodology produces a result with a lower level of precision than that required to inform a full Environmental Impact Assessment (EIA), where baseline information on fish populations prior to the development will need to be collected, often for a number of years. When providing information for EIAs the SFCC recommends that fully-quantitative sampling is performed. However, SFCC classifications are also provided in this report as a useful analysis in a regional context. No such classification system is available for other species i.e. Eurasian minnow or Arctic charr.

The relevant classifications for the Earba survey locations fall within the West Region and are presented below in **Table 3** for streams of <4 m wide and streams of 4-6 m wide.

Table 3: SFCC Fisheries Classification Scheme (West Region – no. fish/100 m^2 in streams <4m and 4-6m wide)

Species/Age-class	Absent	Min to 20th percentile	20th to 40th percentile	40th to 60th percentile	60th to 80th percentile	80th to 100th Percentile
<4 m Wide						
Trout fry 0+	0.0	1.4 - 9.9	9.9 – 28.5	28.5 – 44.7	44.7 – 74.8	74.4 – 181.3
Trout parr 1++	0.0	0.9 – 3.9	3.9 – 5.6	5.6 – 7.6	7.6 – 12.1	12.1 – 66.7
4-6 m Wide						
Trout fry 0+	0.0	0.7 – 3.0	3.0 – 5.0	5.0 – 12.4	12.4 – 19.0	19.0 – 103.5
Trout parr 1++	0.0	0.9 – 2.3	2.3 – 3.3	3.3 – 5.4	5.4 – 8.4	8.4 – 30.3
Description	*Absent*	*Very Poor*	*Poor*	*Moderate*	*Good*	*Excellent*

3 Results

Results of electrofishing are provided in **Table 4** and shown as population density estimates. Electrofishing survey locations are shown in **Appendix A, Figure 1**.

Two fish species were identified via electrofishing: Brown trout and Eurasian minnow (*Phoxinus phoxinus*). No Arctic charr were detected during the 2024 electrofishing surveys during fish processing in the field. Photographs were sent to [redacted] for external verification. The feedback received was that "*none of the fish are unequivocally Arctic charr*", however [redacted] does also note that *"fish under 50 mm* (fork length measurement) *are a bit tricky to be very confident on than larger individuals and there [are] a few of these."*

Table 4. Electrofishing Population Estimates (August 2024)

Survey Location	Survey Technique and Sample Area	Species Recorded and Abundance	Fully-Quantitative Population Estimate	Single-Run Density Estimate
EA1	Fully Quantitative (~97.5 m^2)	Brown trout 0+: 17 Brown trout 1++: 0 Eurasian minnow: 9	Trout 0+: 31.6 Trout 1++: 0.0	Trout 0+: 7.2 Trout 1++: N/A
EA2	Fully Quantitative (95.4 m^2)	Brown trout 0+: 22 Brown trout 1++: 4	Trout 0+: 25.8 Trout 1++: 4.2	Trout 0+: 13.6 Trout 1++: 3.1
EA3	Fully Quantitative (~101.5 m^2)	Brown trout 0+: 6 Brown trout 1++: 1 Eurasian minnow: 4	Trout 0+: 6.1 Trout 1++: 1.0	Trout 0+: 3.9 Trout 1++: 1.0
EA5	Fully Quantitative (~101.25 m^2)	Brown trout 0+: 45 Brown trout 1++: 2 Eurasian minnow: 10	Trout 0+: 58.0 Trout 1++: 2.0	Trout 0+: 20.9 Trout 1++: 1.0
EA6	Fully Quantitative (~100.5 m^2)	Brown trout 0+: 10 Brown trout 1++: 5	Trout 0+: 11.7 Trout 1++: 8.3	Trout 0+: 6.0 Trout 1++: 3.0

Table 5. SFCC Fisheries Classification Scheme Ratings (August 2024)

Survey Location	Trout 0+:	Trout 1++:
EA1	*Moderate*	*Absent*
EA2	*Good*	*Poor*
EA3	*Very Poor*	*Very Poor*
EA5	*Poor*	*Very Poor*
EA6	*Moderate*	*Poor*

4 Discussion

In total, two fish species were identified during electrofishing surveys: Brown trout and Eurasian minnow.

Brown trout showed the greatest distribution within the survey areas and were present in all of the watercourses surveyed. Eurasian minnow were similarly present in three of the five electrofishing survey locations. No Arctic charr were detected within the Survey Locations at the time of survey.

Brown trout fry (0+) were present at survey locations EA1 – EA6. Brown trout parr (1++) were present at survey locations (EA2, EA3, EA5 and EA6) but absent from EA1, possibly due to a lack of bankside cover and large substrate which provides instream cover for larger fish.

Fully quantitative population estimates for brown trout fry (0+) ranged from 6.1 per 100m^2 (EA3) to 58 per 100m^2 (EA5). For brown trout parr (1++), most densities captured were low therefore some of the results could not be applied to the statistical depletion model (EA1, EA3 & EA5). These densities are expressed as a minimum estimate. Fully quantitative density estimates for brown trout parr ranged from 4.2 per 100 m^2 (EA2) – 8.3 per 100 m^2 (EA6). Including minimum density estimates, densities ranged from absent (EA1) to 8.3 per 100 m^2 (EA6).

SFCC regional classification scheme ratings for brown trout fry ranged from *Very Poor (EA3)* to *Poor* (EA5) to *Moderate* (EA1 & EA6) to *Good* (EA2) and for brown trout parr ranged from *Absent* (EA1) to *Very Poor* (EA3 and EA5) to *Poor* (EA2 & EA6). Stream width has a bearing on the SFCC classification with stream widths of <4 m requiring much higher densities to achieve *Moderate* / *Good* / *Excellent* classification status than stream widths of 4-6 m.

Observed *Moderate* to *Good* fry densities are representative of successful recruitment during the previous spawning season. All of the survey locations are accessible to larger adult fish emanating from the Loch Earba basins which are likely to utilise these tributaries for spawning.

All fish populations are considered natural and self-sustaining; there were no records of stocking identified during previous desk studies.

If Arctic charr are present in some the watercourses surveyed, which is suggested as feasible by the possible identification of sub-50mm specimens in the 2023 electrofishing surveys, none were detected in the 2024 electrofishing surveys. Visual identification can be difficult in very small specimens of Arctic charr thus this record from 2023 must be treated with some caution particularly as there was no confirmation by genetic analysis.

It is possible that in 2023, if Arctic charr were in fact present, these were juveniles using burns as nursery areas (Maitland *et al.*, 1984) and this recruitment did not take place during the following spawning season. Another explanation for the possible presence in 2023 and subsequent absence of Arctic charr in 2024 may be that the juveniles had already migrated downstream to Loch Earba before the time that the electrofishing survey had taken place. This may also explain why there were no 1++ juvenile charr / adult charr present at the survey locations. This represents a limitation to the population survey and is a trade off against juvenile fry being of suitable size to identify to species level. It was previously agreed with SEPA that the population survey should take place later on in the survey season (mid to late August) to allow for easier identification of fry to species level.

While every professional effort has been made to accurately speciate all individual fish captured (including the use of expert external verification), there remains a possibility that individual fish specimens may have been mis-identified (either during the 2023 or 2024 survey results). There is a recognised difficulty in accurately speciating fish fry specimen in individuals which are <50mm in length.

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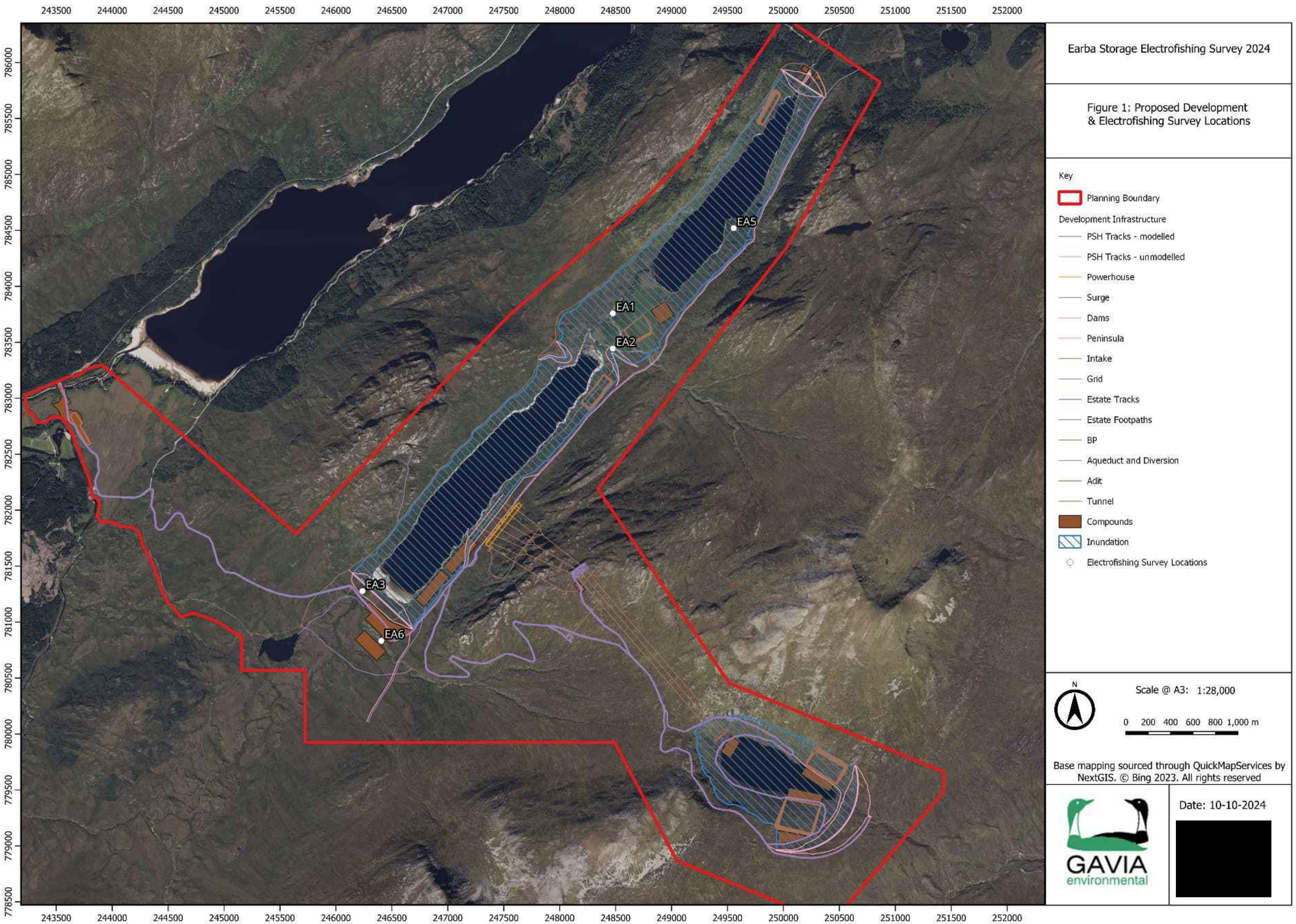
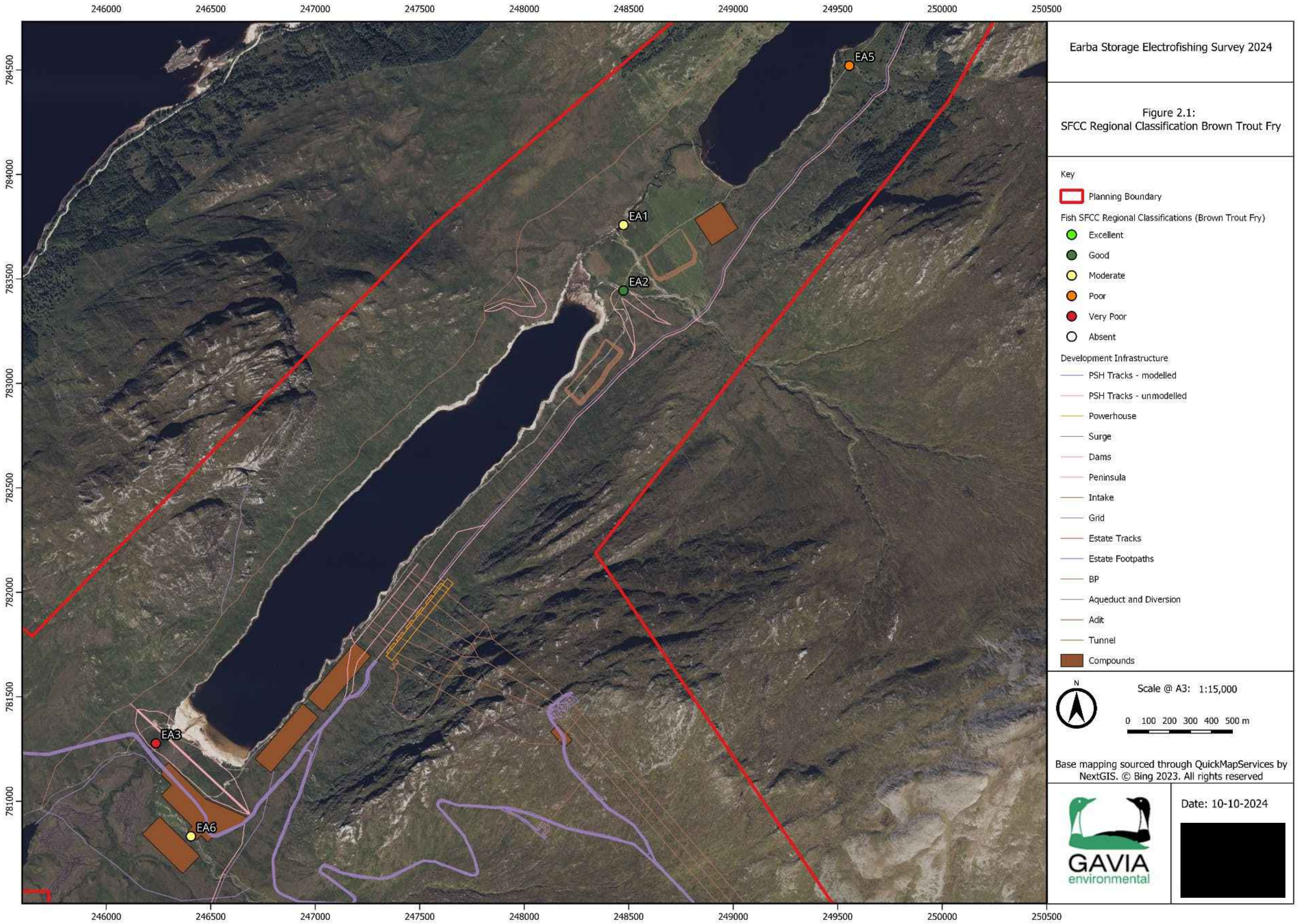
Maitland, [redacted] The status and biology of Arctic charr, *Salvelinus alpinus* (L.), in Scotland. In: [redacted] Biology of the Arctic Charr: proceedings of the international symposium on Arctic charr, Winnipeg, Manitoba, May 1981 Winnipeg, Canada: University of Manitoba Press. pp. 193-216.

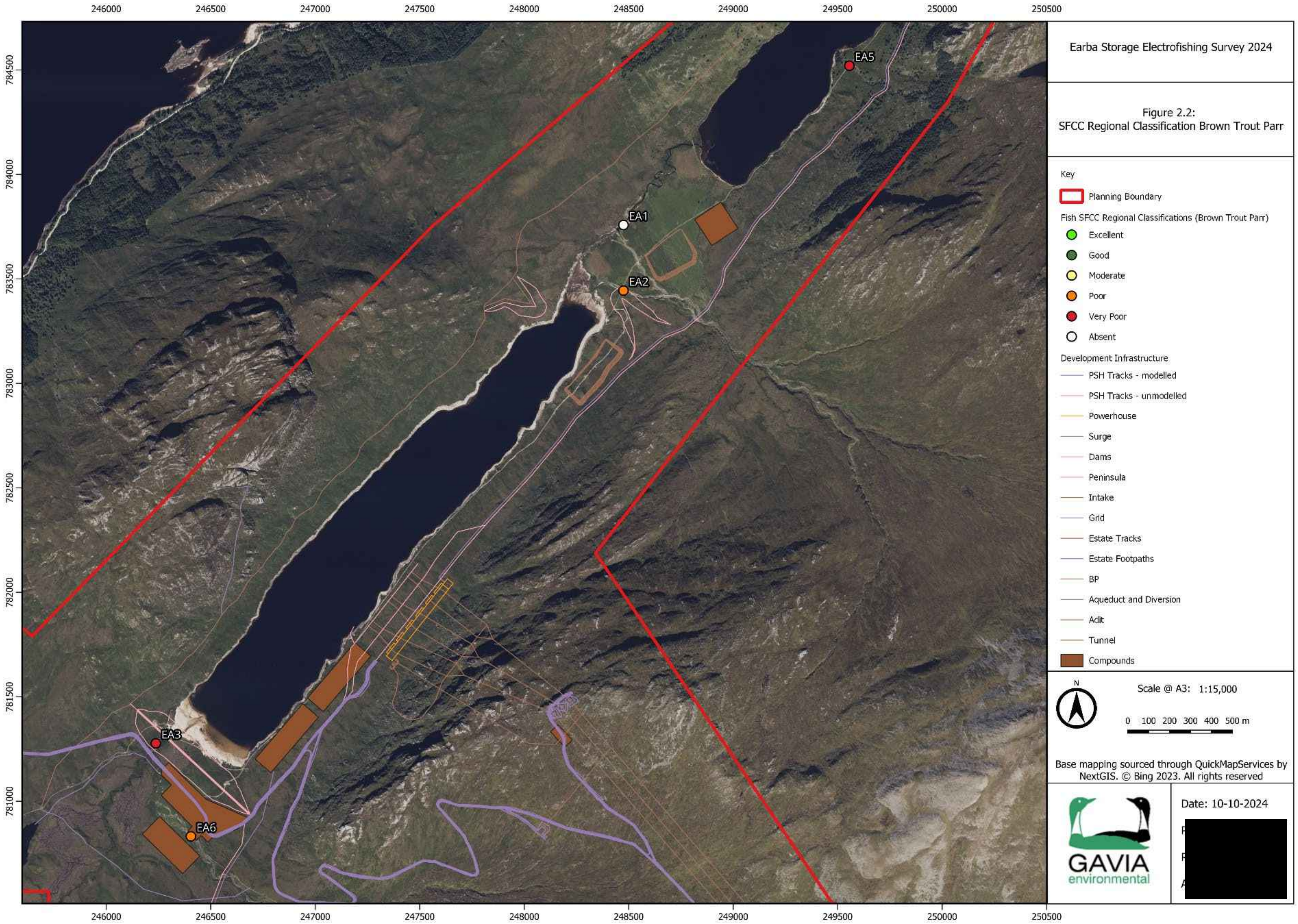
Scottish Fisheries Co-ordination Centre. (2007) Electrofishing Team Leader Training Manual: Managing Electrofishing Operations. SFCC, Pitlochry.

Appendices

Appendix A Figures


Earba Storage Electrofishing Survey 2024
Figure 1: Proposed Development & Electrofishing Survey Locations
Key
Planning Boundary
Development Infrastructure
PSH Tracks - modelled
PSH Tracks - unmodelled
Powerhouse
Surge
Dams
Peninsula
Intake
Grid
Estate Tracks
Estate Footpaths
BP
Aqueduct and Diversion
Adit
Tunnel
Compounds
Inundation
Electrofishing Survey Locations
EA1
EA2
EA3
EA5
EA6
N
Scale @ A3: 1:28,000
0 200 400 600 800 1,000 m
Base mapping sourced through QuickMapServices by NextGIS. © Bing 2023. All rights reserved
GAVIA environmental
Date: 10-10-2024
[redacted]


Earba Storage Electrofishing Survey 2024
Figure 2.1:
SFCC Regional Classification Brown Trout Fry
Key
Planning Boundary
Fish SFCC Regional Classifications (Brown Trout Fry)
Excellent
Good
Moderate
Poor
Very Poor
Absent
Development Infrastructure
PSH Tracks - modelled
PSH Tracks - unmodelled
Powerhouse
Surge
Dams
Peninsula
Intake
Grid
Estate Tracks
Estate Footpaths
BP
Aqueduct and Diversion
Adit
Tunnel
Compounds
N
Scale @ A3: 1:15,000
0 100 200 300 400 500 m
Base mapping sourced through QuickMapServices by NextGIS. © Bing 2023. All rights reserved
GAVIA
environmental
Date: 10-10-2024
[redacted]
EA1
EA2
EA3
EA5
EA6
246000
246500
247000
247500
248000
248500
249000
249500
250000
250500
784500
784000
783500
783000
782500
782000
781500
781000


Earba Storage Electrofishing Survey 2024
Figure 2.2:
SFCC Regional Classification Brown Trout Parr
Key
Planning Boundary
Fish SFCC Regional Classifications (Brown Trout Parr)
Excellent
Good
Moderate
Poor
Very Poor
Absent
Development Infrastructure
PSH Tracks - modelled
PSH Tracks - unmodelled
Powerhouse
Surge
Dams
Peninsula
Intake
Grid
Estate Tracks
Estate Footpaths
BP
Aqueduct and Diversion
Adit
Tunnel
Compounds
N
Scale @ A3: 1:15,000
0 100 200 300 400 500 m
Base mapping sourced through QuickMapServices by NextGIS. © Bing 2023. All rights reserved
GAVIA
environmental
Date: 10-10-2024
[redacted]
EA1
EA2
EA3
EA5
EA6
246000
246500
247000
247500
248000
248500
249000
249500
250000
250500
784500
784000
783500
783000
782500
782000
781500
781000

Appendix B Photographs

Plate Number	Description	Photograph
Survey Locations		
1	EA1 – View downstream from the top end of the survey location.	

2	EA2 – View downstream from the top of the survey location.	
3	EA3 – Upstream and downstream views of the survey location.	 

4	EA5 – View downstream from the top of the survey location.	
5	EA6 – View upstream from the bottom of the survey location.	

Fish			
6	EA1 – Brown trout fry present		

7	EA2 – Brown trout fry and parr	 

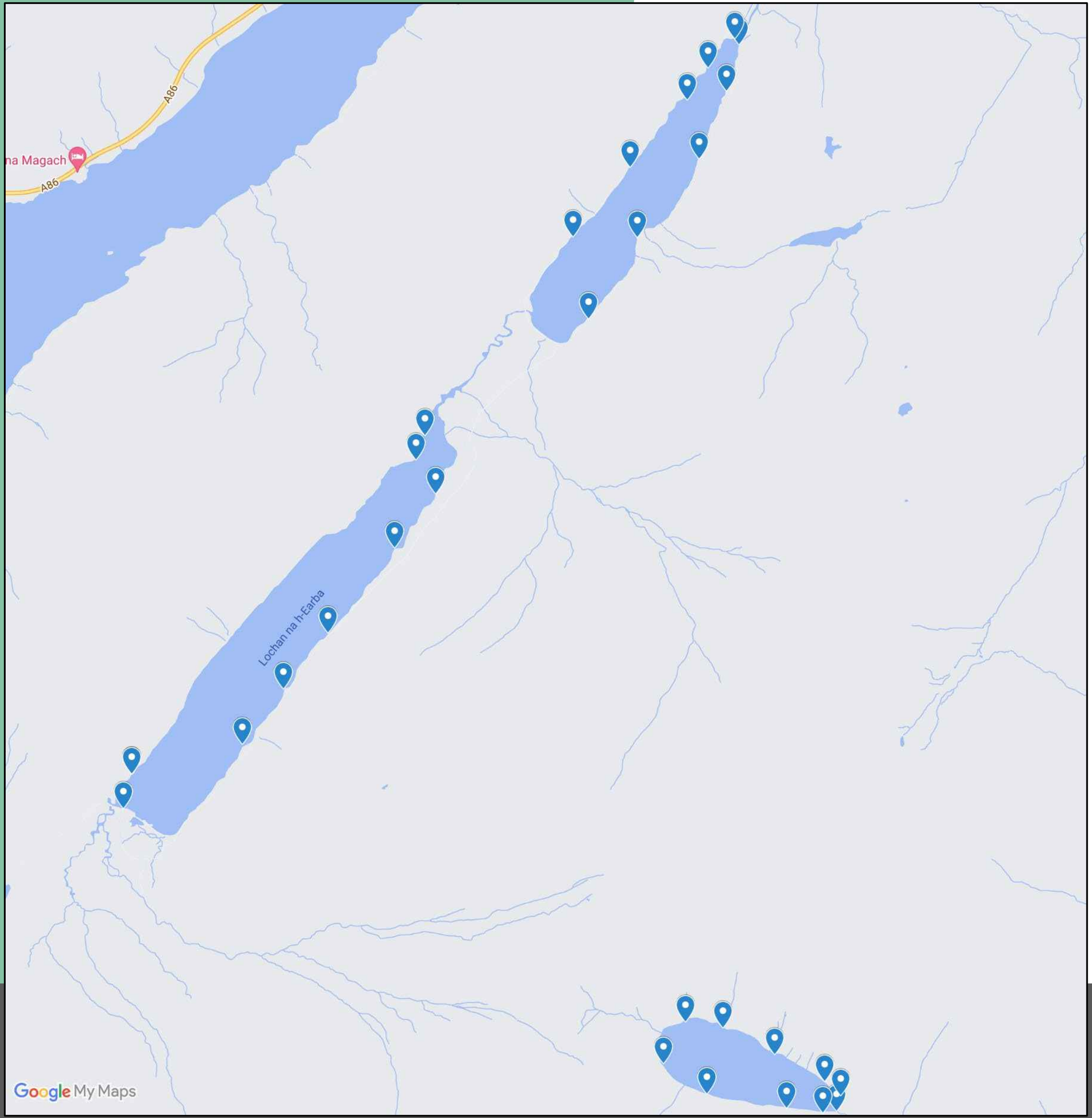
	EA5 – Common minnow			

Appendix G eDNA Survey Preliminary Presentation (2024)

Earba PSH – eDNA preliminary reporting of final survey results

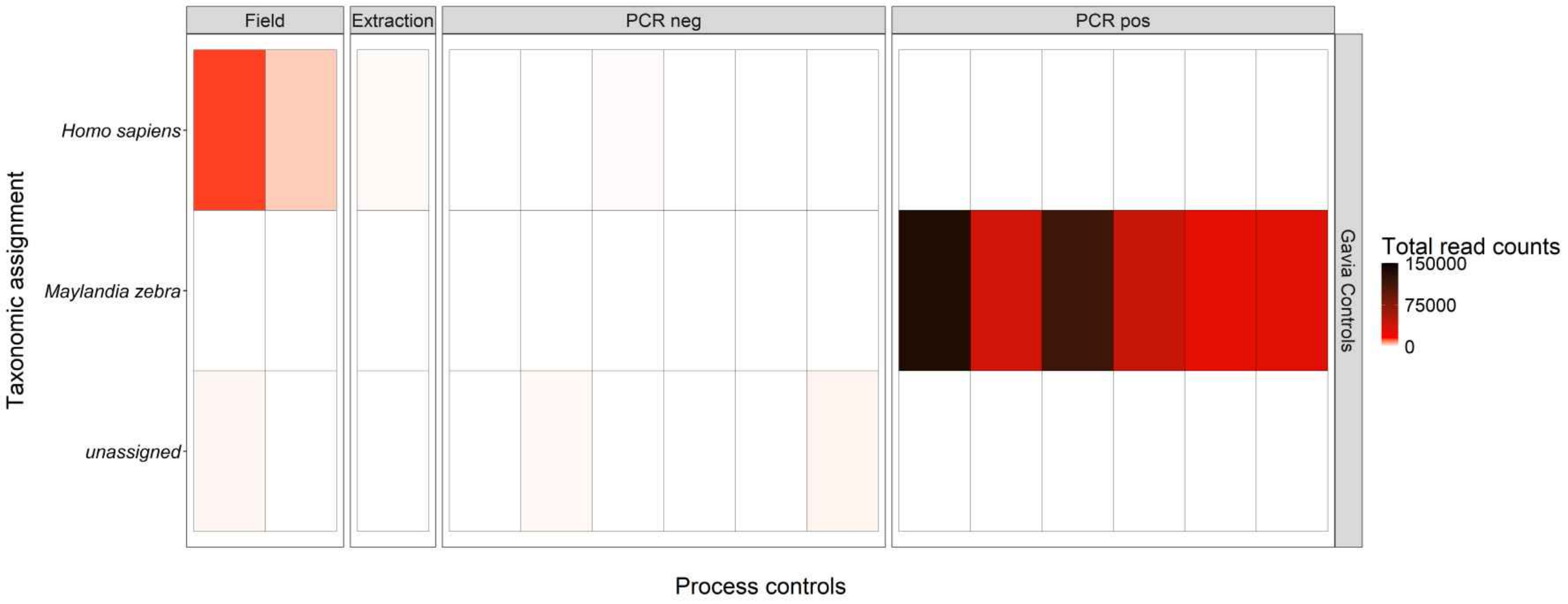
November 2024

Explanatory note: These slides include the preliminary reporting of the final results of a an eDNA survey investigation undertaken on Lochan na-hEarba (East basin), Lochan na-hEarba (West basin) and Loch Leamhain in October 2024. They were first presented by [redacted] of UHI's Institute for Biodiversity and Freshwater Conservation on 05/11/2024. It is anticipated that this slide pack will be replaced by UHI's final project report as soon as it is available – which is estimated to be during December 2024.

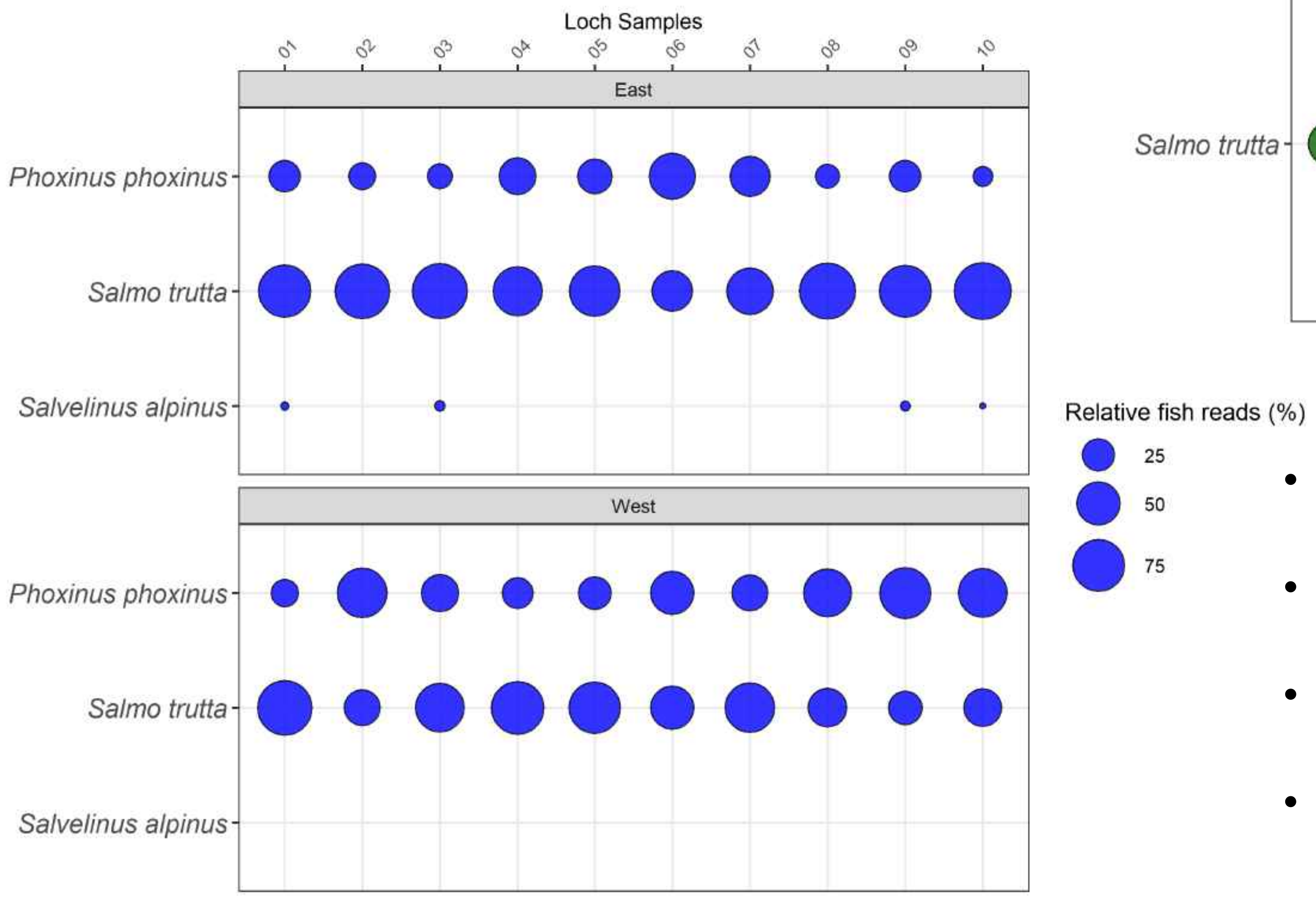


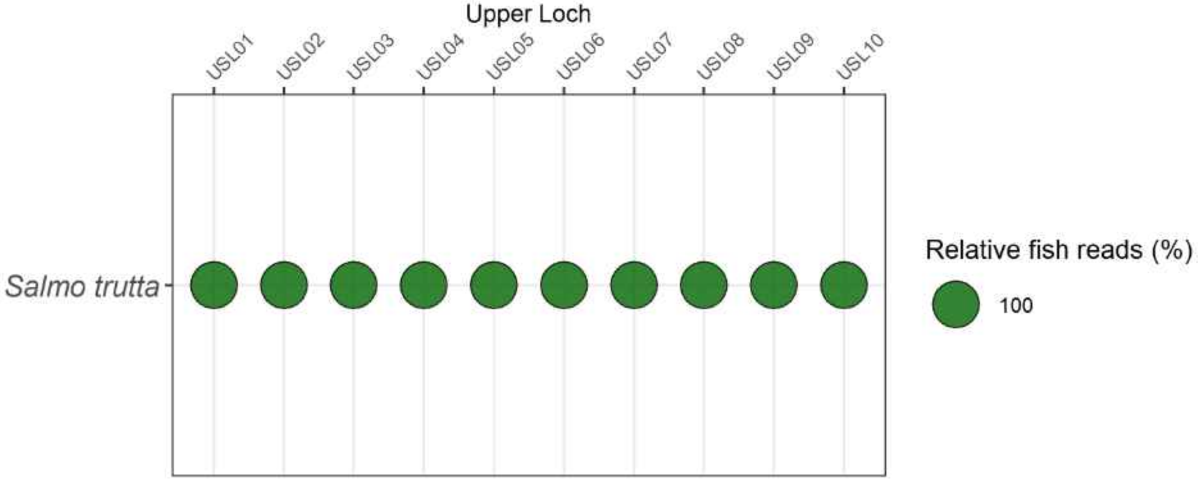
- 30x eDNA water samples taken.
- 10x Upsteam loch.
- 20x Lower loch (10 each sub-basin).
- We are using a 12S Vertebrate marker.
- Previous work has shown high sensitivity for detecting whole fish communities, with 10x sufficient for reliably detecting fish in large lochs / reservoirs.

Contamination / Quality controls



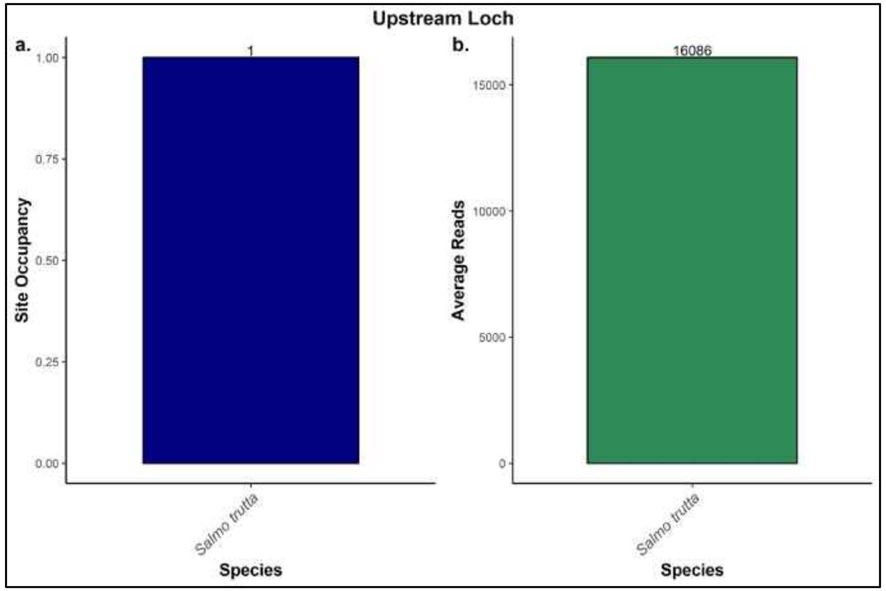
Fish community detected

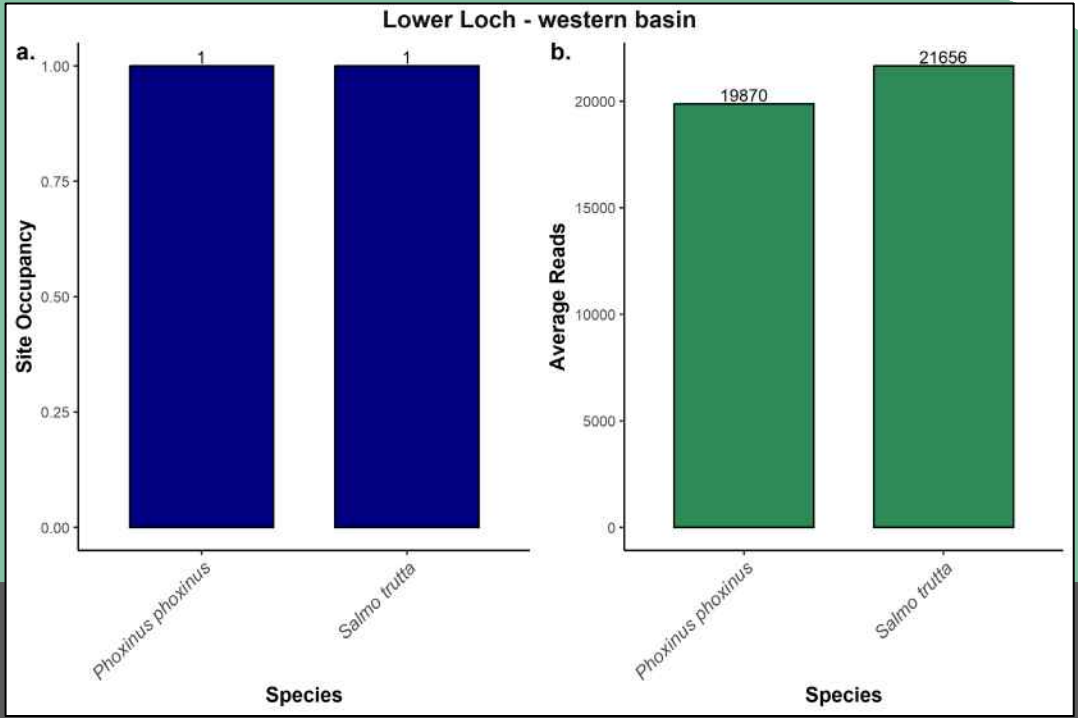


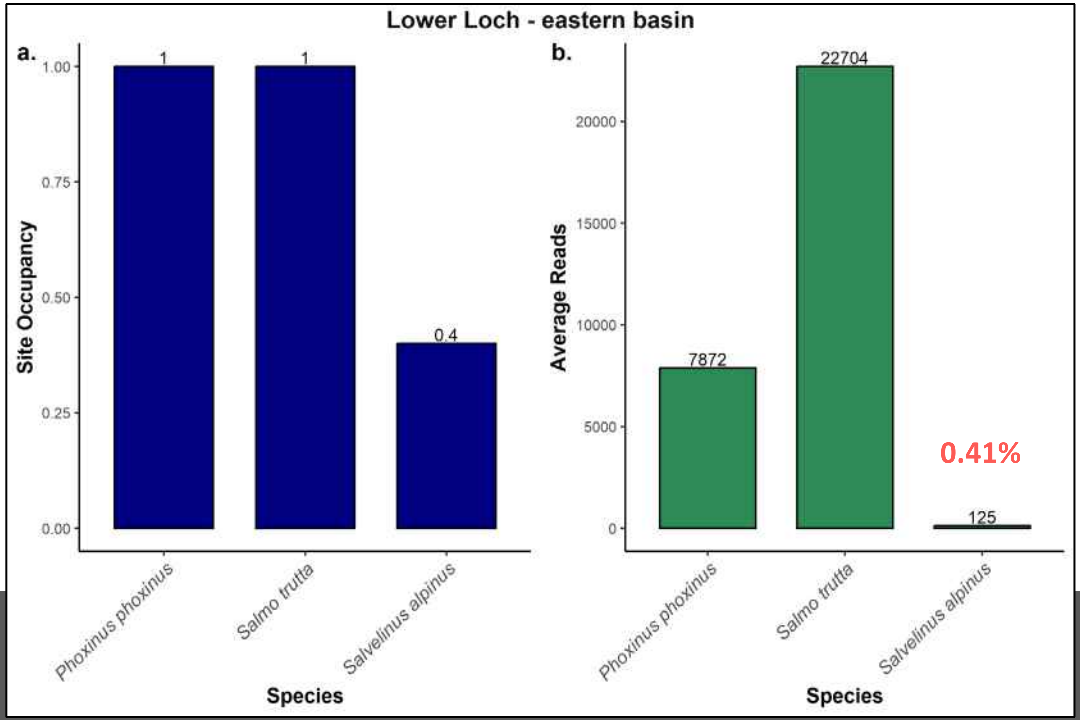


- Only 3x fish species detected across survey.
- 1x in the Upper Loch.
- 3x across Lower Lochs.
- Arctic charr detected only in the Eastern basin.

Relative species abundance



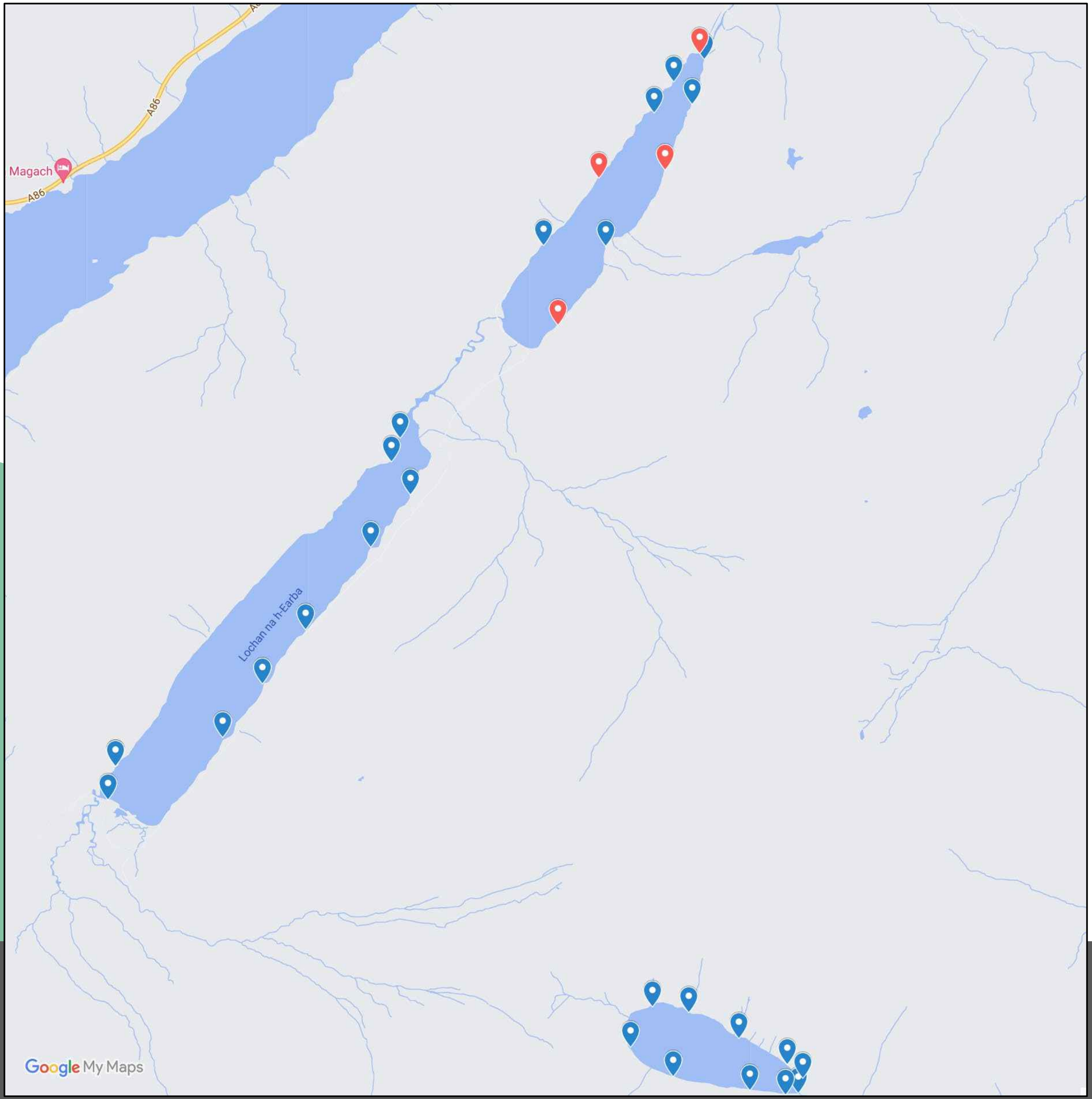




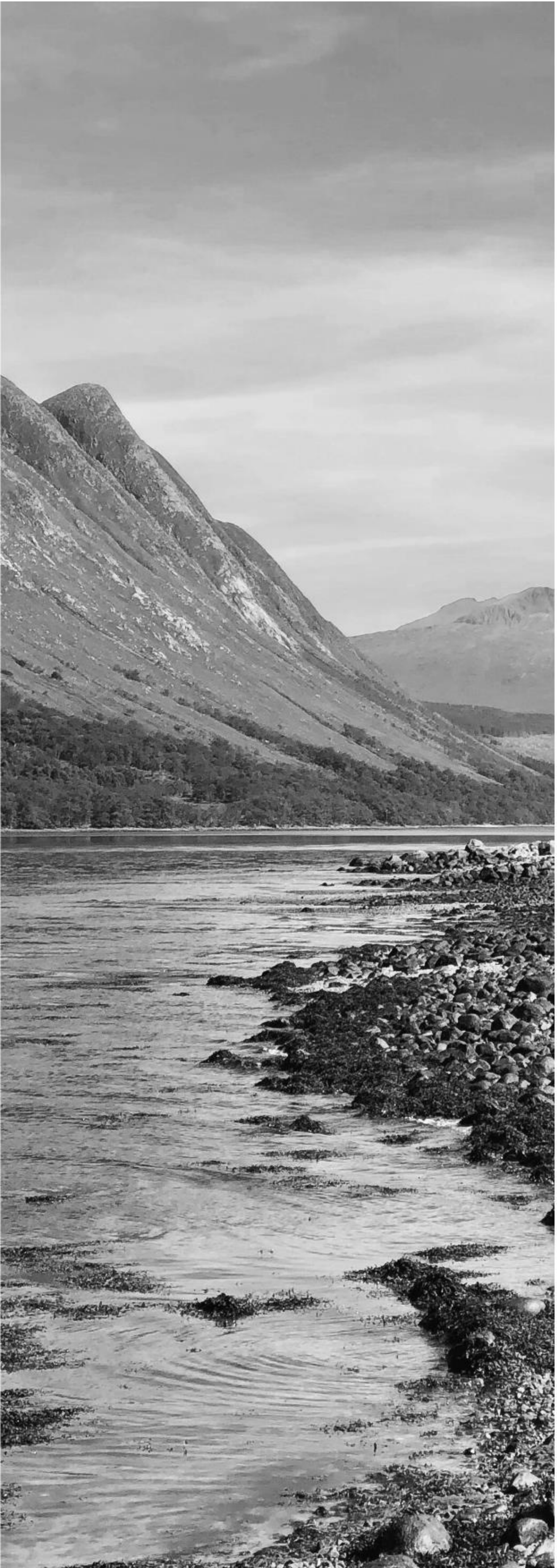
Spatial charr detection

Sample taken

Arctic Charr detected



Appendix H Arctic Charr Species Protection Plan



ARCTIC CHARR SPECIES PROTECTION PLAN

EARBA PUMPED STORAGE HYDROSCHEME

EARBA LTD.

19/12/2024

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Report prepared for	Earba Ltd. Canal Head North Kendal LA9 7BZ
Project name	EARBA Pumped Storage Hydroscheme
Project number	P24105
Prepared by	[redacted]
Approved by	[redacted]

Revision History

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

GAVIA environmental

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 Professor Adams 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 [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] 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.

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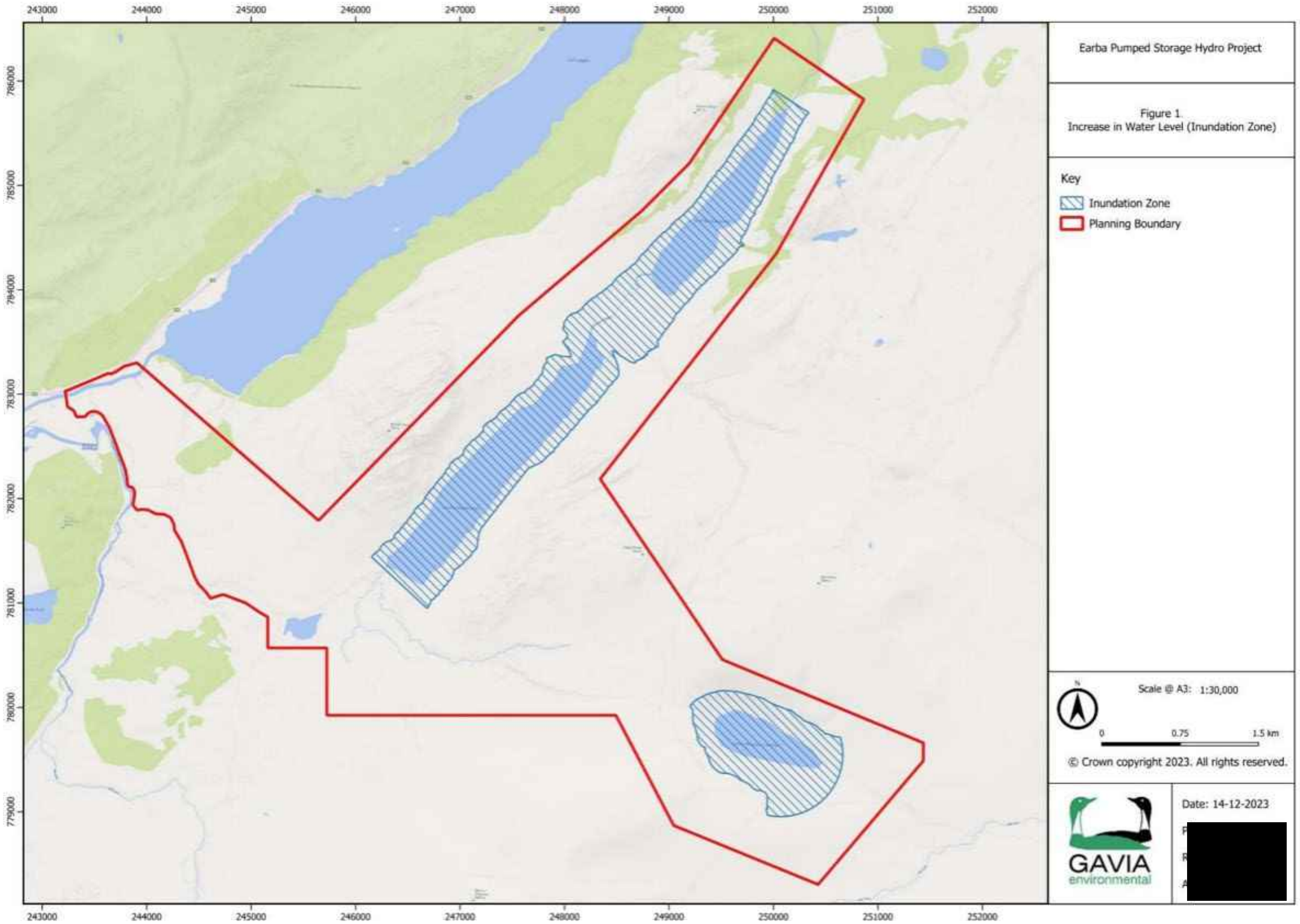
Appendices

Appendix A Proposed Development



Appendix B Artificial Floating Spawning Nest Schematic

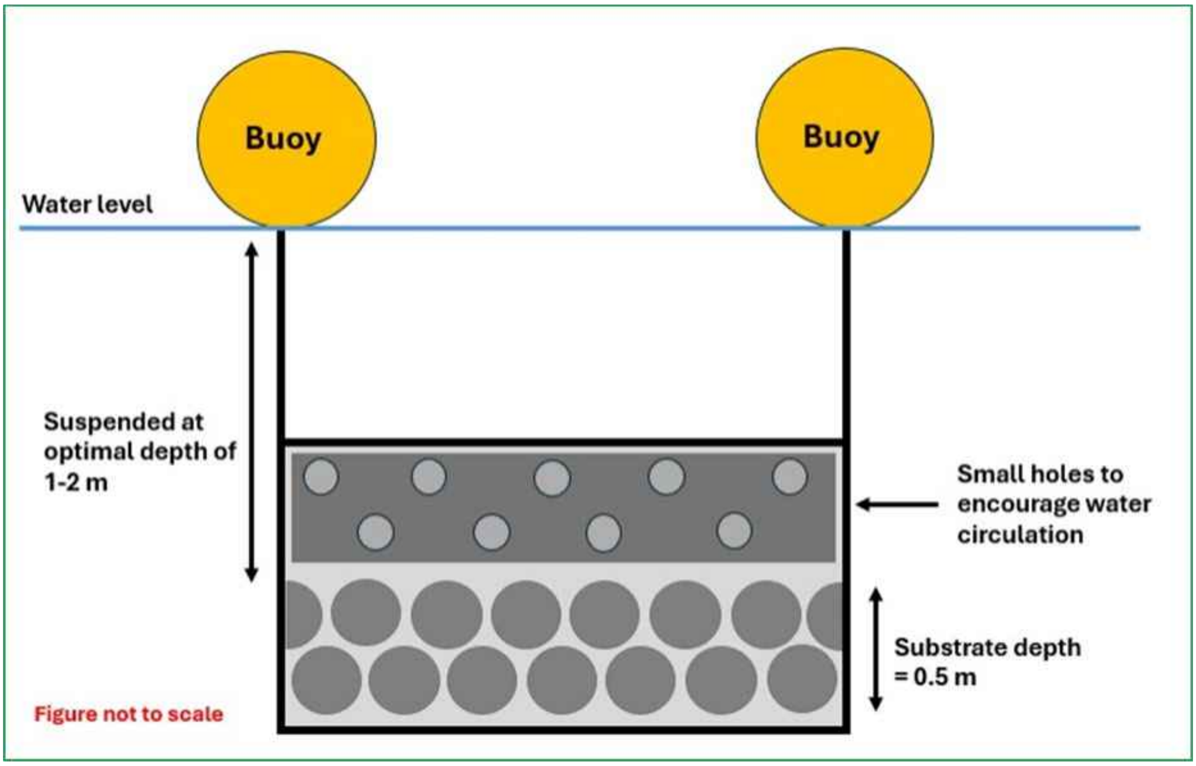


Figure 2. Cross-section of a proposed design for the artificial floating spawning nests

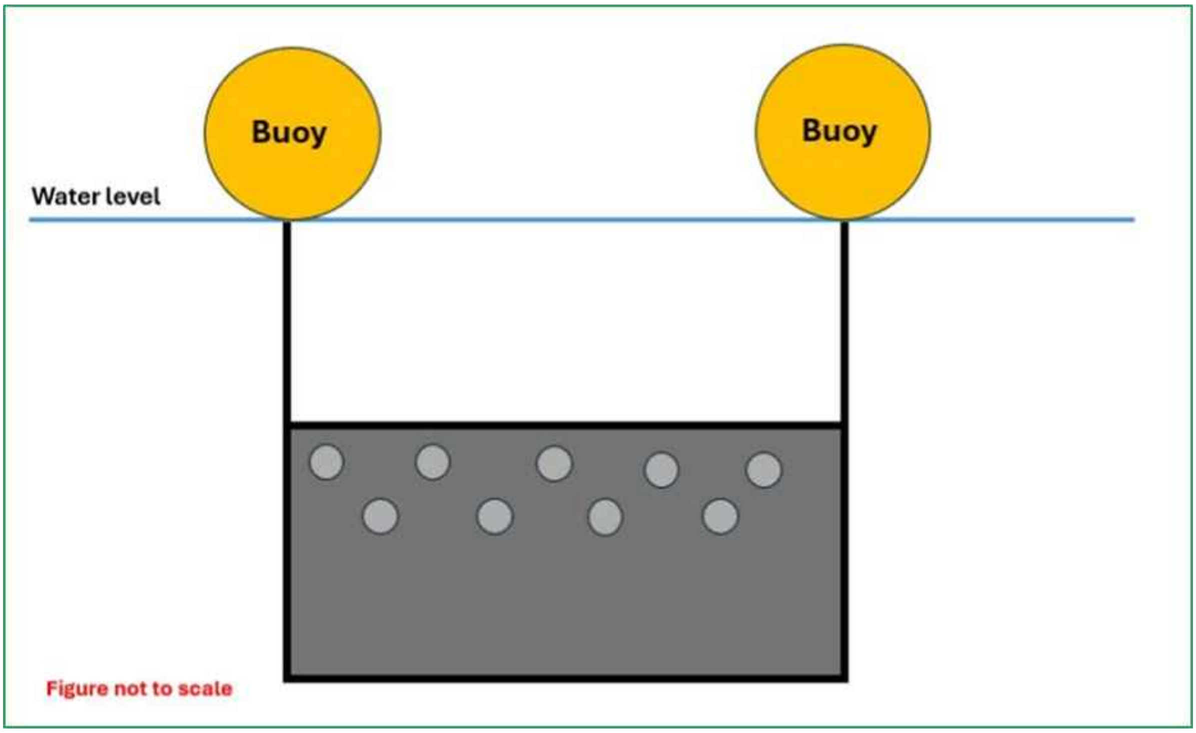


Figure 3. Side profile of proposed design for the artificial floating spawning nests

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.

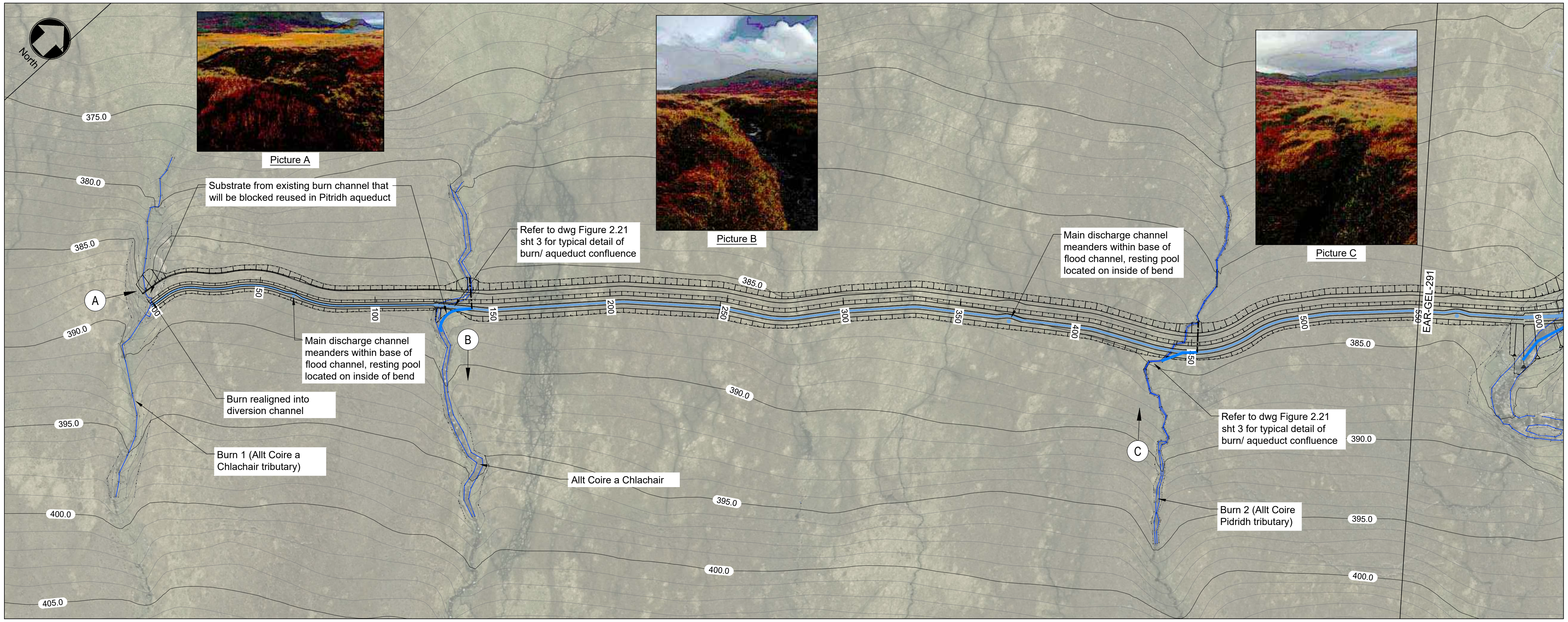
The negative element of this as a mitigation is that it is likely that a proportion of the population may continue to spawn in good quality spawning areas that are within the drawdown zone and thus are subsequently dried. Thus provision of a suitable quantity of such managed habitat and a robust management 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



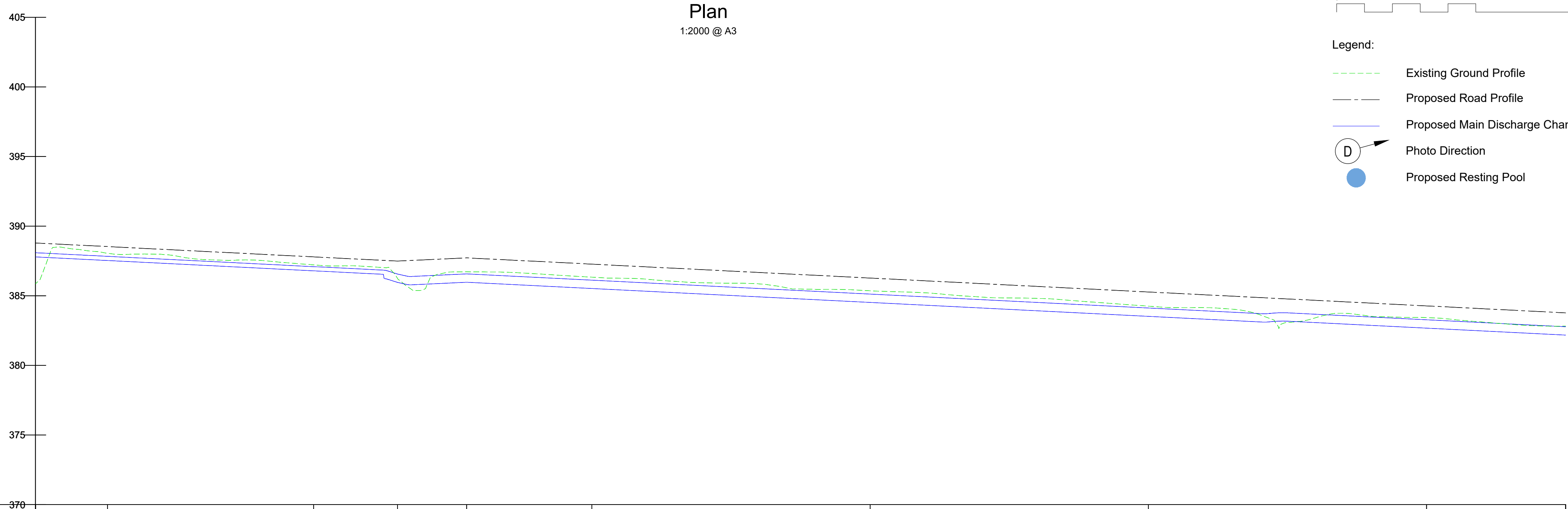
Plan

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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6. Resting pools shown indicatively on aqueduct plan. Final location to be agreed with an experienced fish ecologist at the detailed design stage.
7. Aqueduct channel substrates would be formed using natural sediments local to the system, to provide a well-graded mix of sediment appropriate to the energy regime of a stepped pool channel.
8. CCTV coverage at the confluence of existing burn and channel would will provide real time monitoring of flow and sediment conditions.

Bridge Notes

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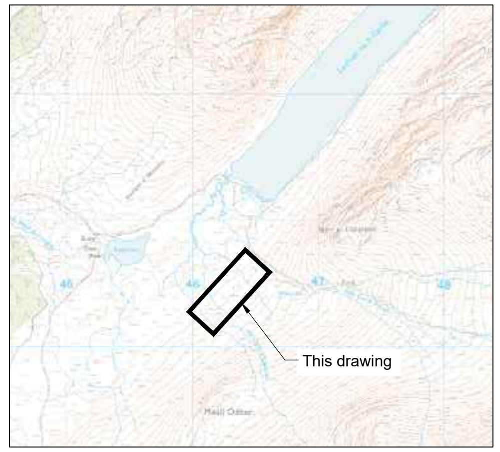
5. The registration with SEPA of all new bridges will be undertaken on completion of detailed design.



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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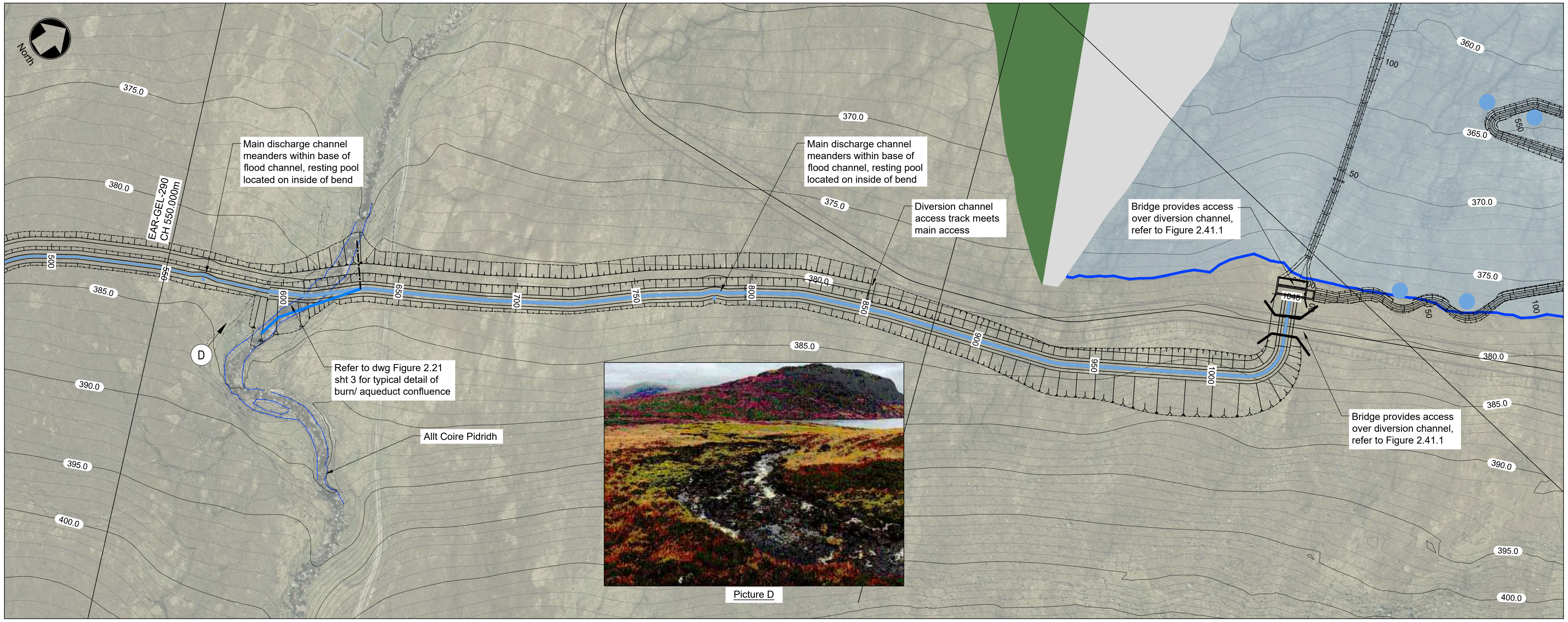
TITLE

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

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

DRAWING NUMBER	REVISION
EAR/GEL/290	P1

IF IN DOUBT - ASK



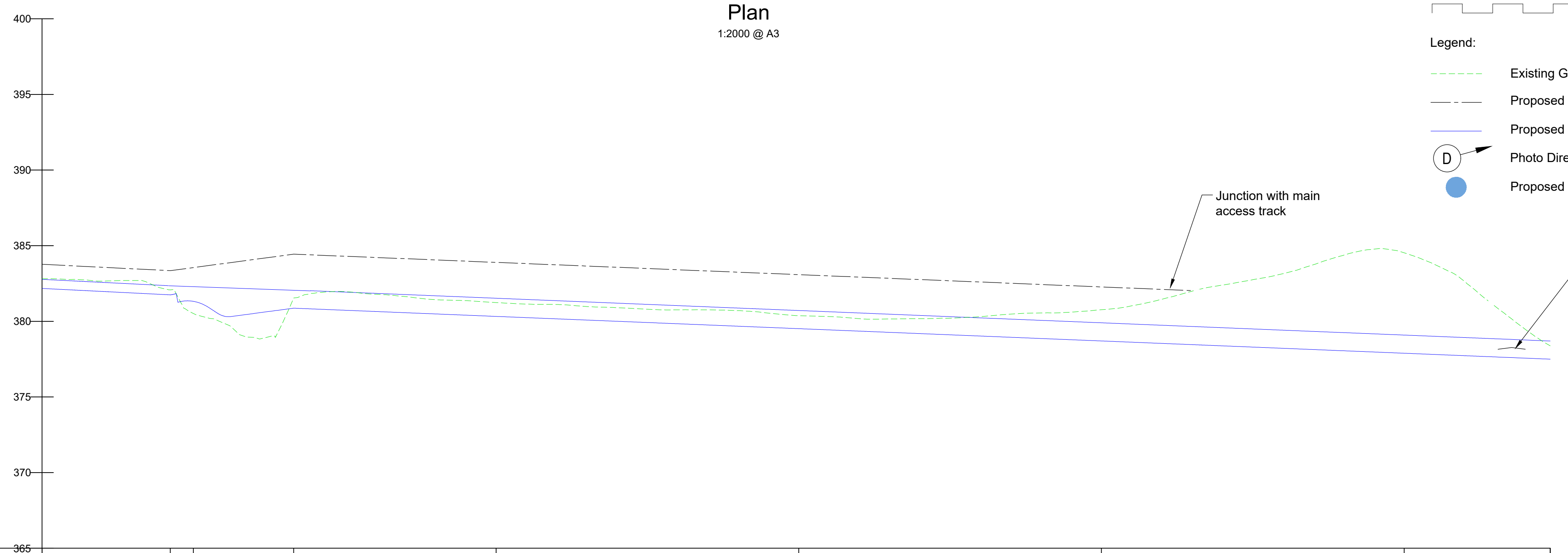
Picture D

Plan

1:2000 @ A3

Legend:

- Existing Ground Profile
- Proposed Road Profile
- Proposed Main Discharge Channel Profile
- (D) 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				

NOTES

Aqueduct Notes

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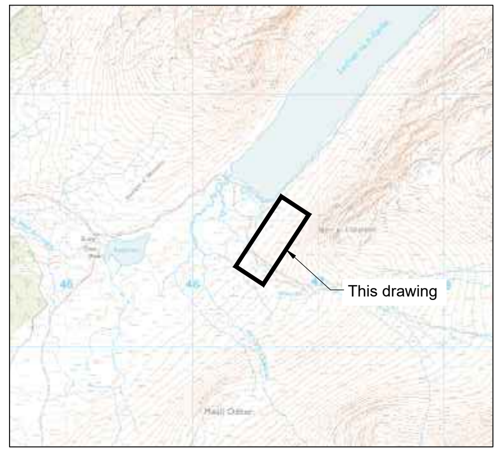

Location Plan

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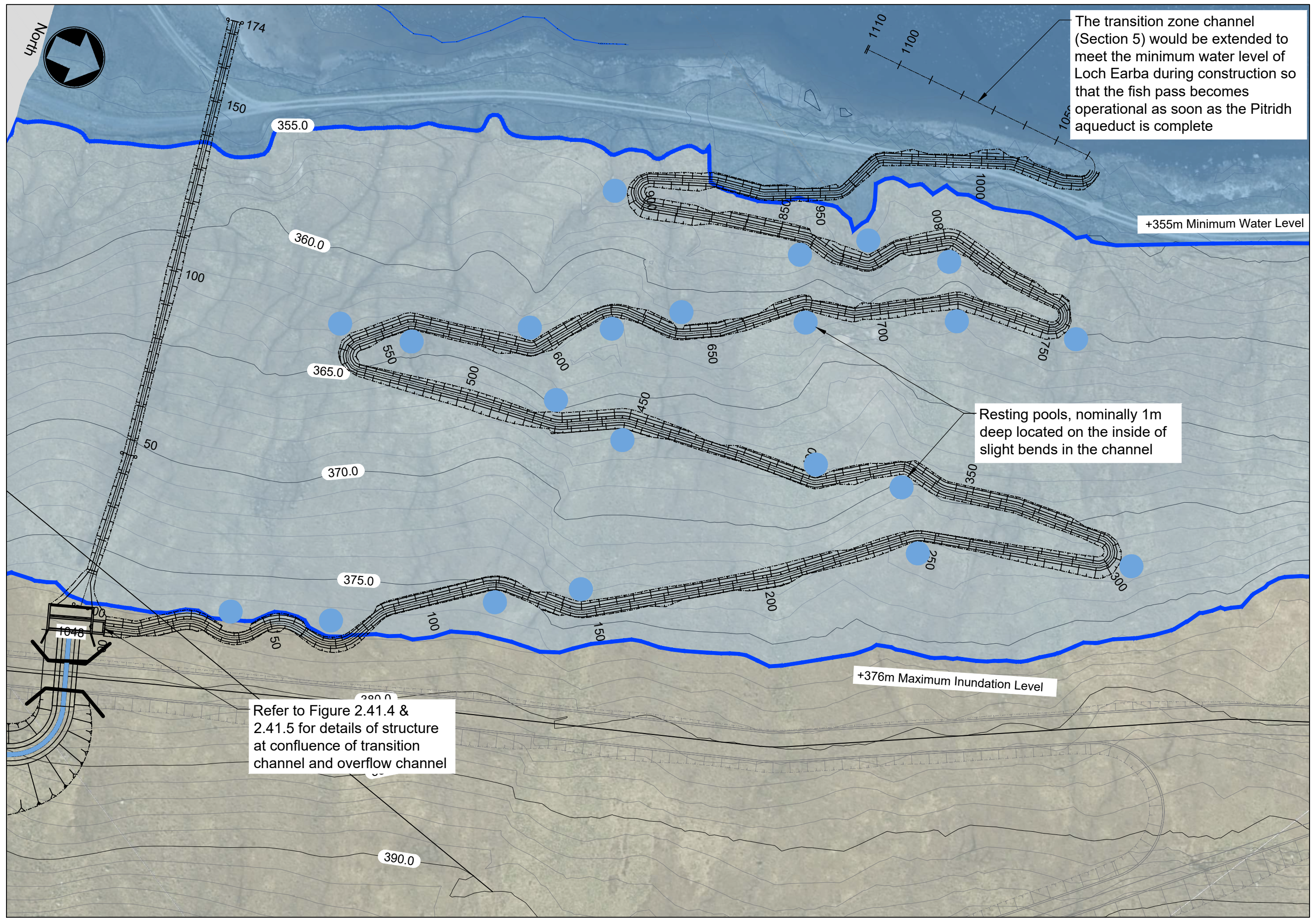
PITRIDH CHANNEL DIVERSION PLAN AND LONG SECTION FIGURE 2.20 - SHEET 2

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

DRAWING NUMBER	REVISION
EAR/GEL/291	P1



Plan

1:2000 @ A3

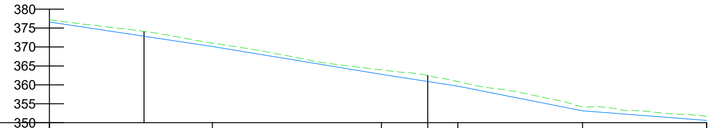
Legend:

- 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



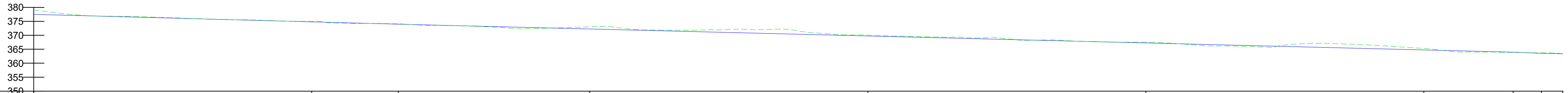
Chainage	0.000	43.063	87.781	100.000	107.989	140.943	173.759
Existing Levels	377.196	371.038	363.933	362.469	360.864	354.153	351.662
Proposed Levels	376.601	370.130	362.781	360.881	359.638	353.131	350.576
Aqueduct Section Refer to Figure 2.21 Sheet 1	Section 6 Gradient Varies, typically 10% - 14%						

0 50m 100m

LONGITUDINAL SECTION

(SC3 CHANNEL)

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



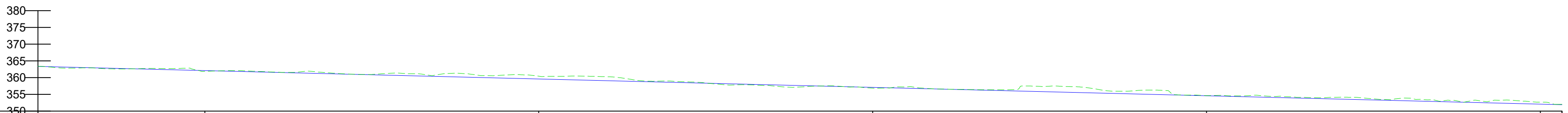
Chainage	0.000	100.000	131.168	200.000	300.000	400.000	500.000	532.130	542.291	550.000
Existing Levels	379.116	375.019	374.142	373.058	370.089	367.531	365.295	363.864	363.759	363.435
Proposed Levels	377.500	374.814	373.977	372.256	369.756	367.256	364.756	363.953	363.546	363.353
Aqueduct Section Refer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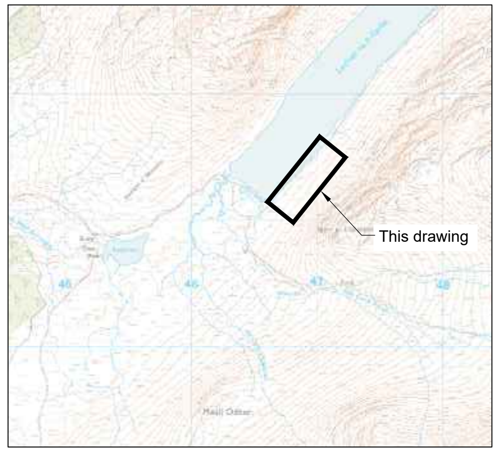

Location Plan

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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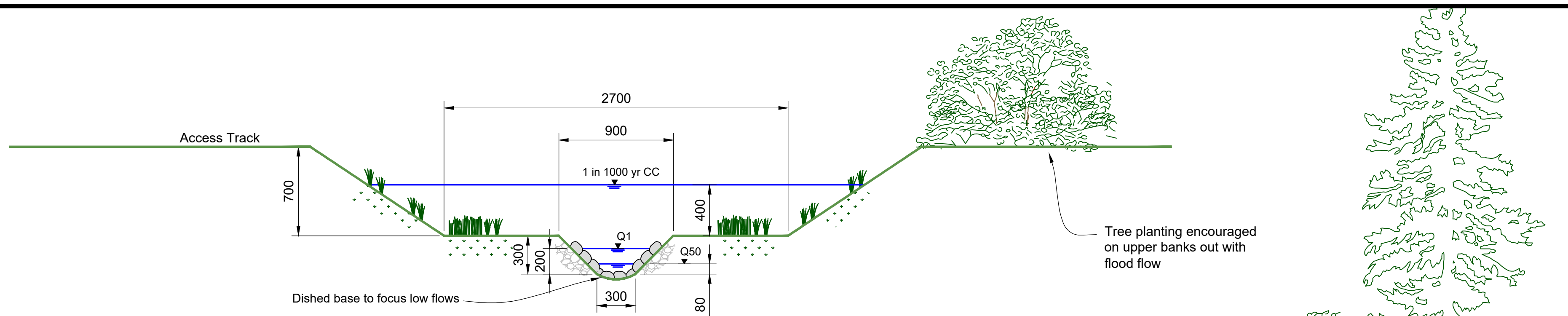
TITLE

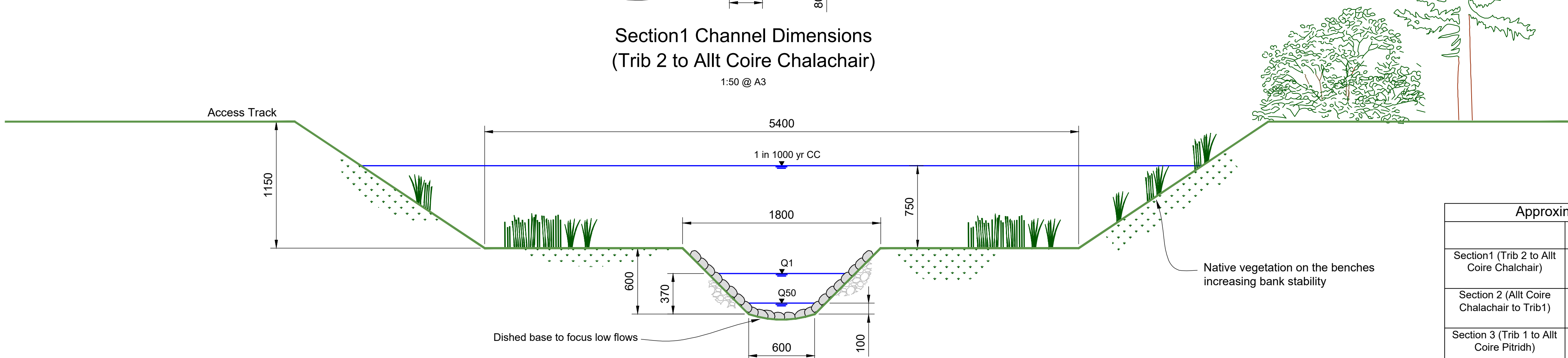
PITRIDH CHANNEL DIVERSION PLAN AND LONG SECTION FIGURE 2.20 - SHEET 3

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

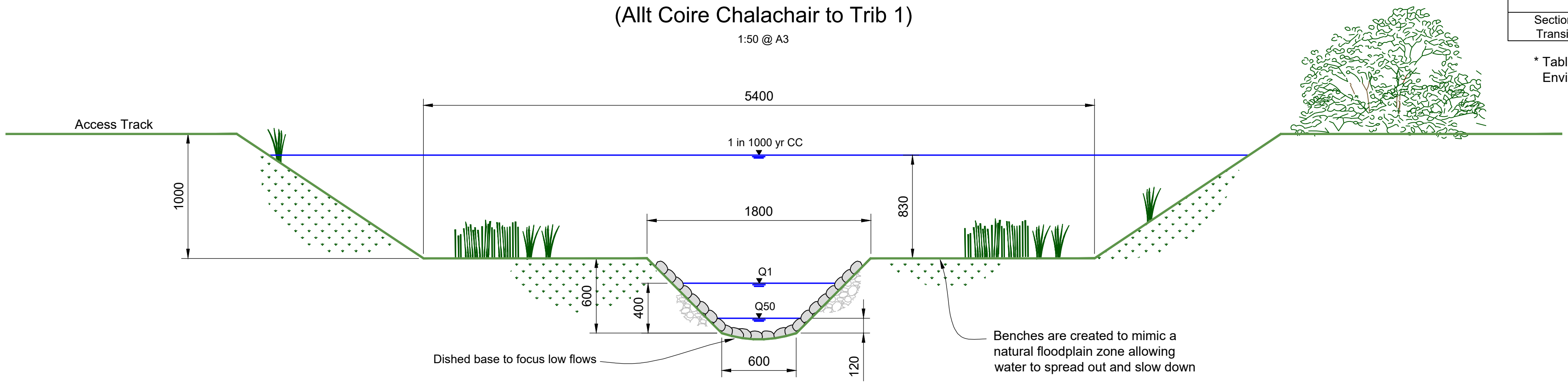
DRAWING NUMBER EAR/GEL/292 | REVISION P1



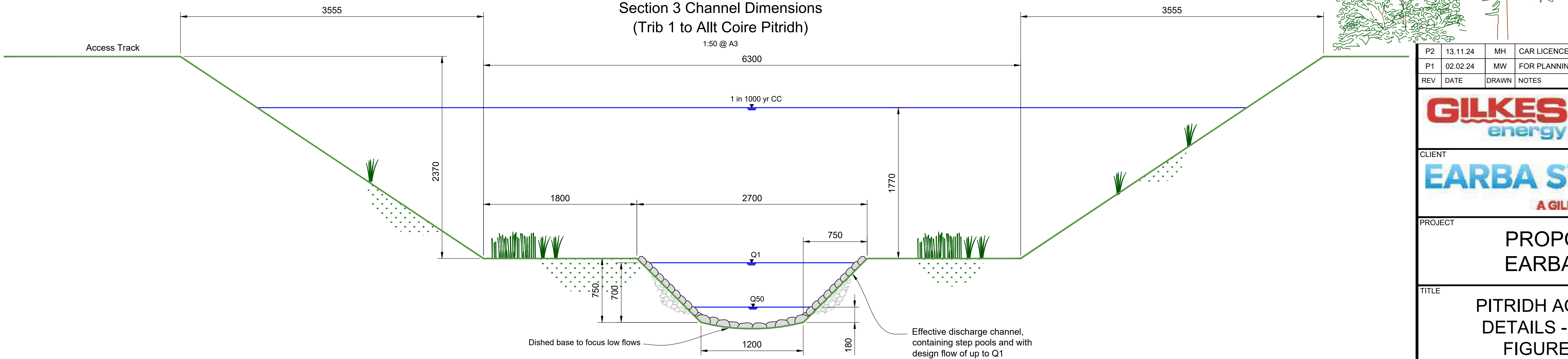
Section1 Channel Dimensions
(Trib 2 to Allt Coire Chalachair)
1:50 @ A3



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	CHK'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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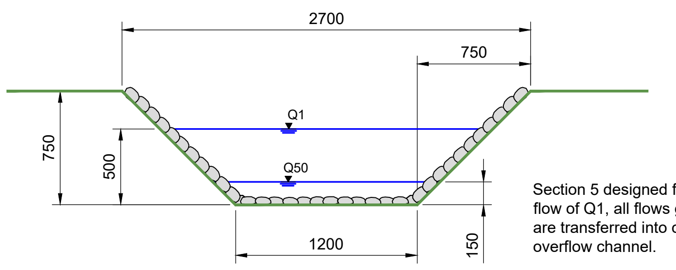
PROJECT
PROPOSED
EARBA PSH

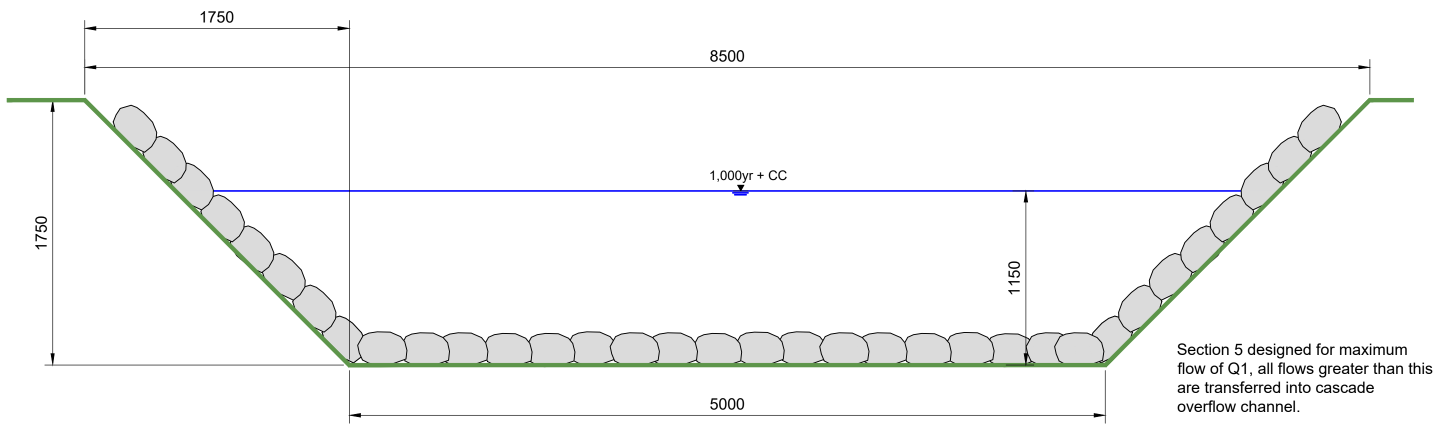
TITLE
PITRIDH AQUEDUCT
DETAILS - SHEET 1
FIGURE 2.21.1

SIZE	SCALE AT A3	STATUS
A3	1:50	PLANNING

DRAWING NUMBER	REVISION
EAR/GEL/295	P2



Section 5 Channel Dimensions
(Loch Earba transition zone and Moy Habitat Channel)
1:50 @ A3



Section 6 Channel Dimensions
(Loch Earba transition zone overflow channel)
1:50 @ A3

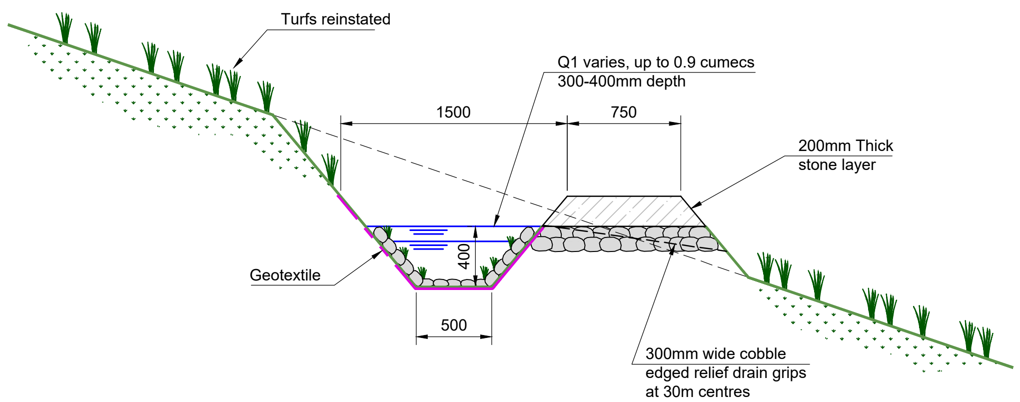
IF IN DOUBT - ASK

NOTES

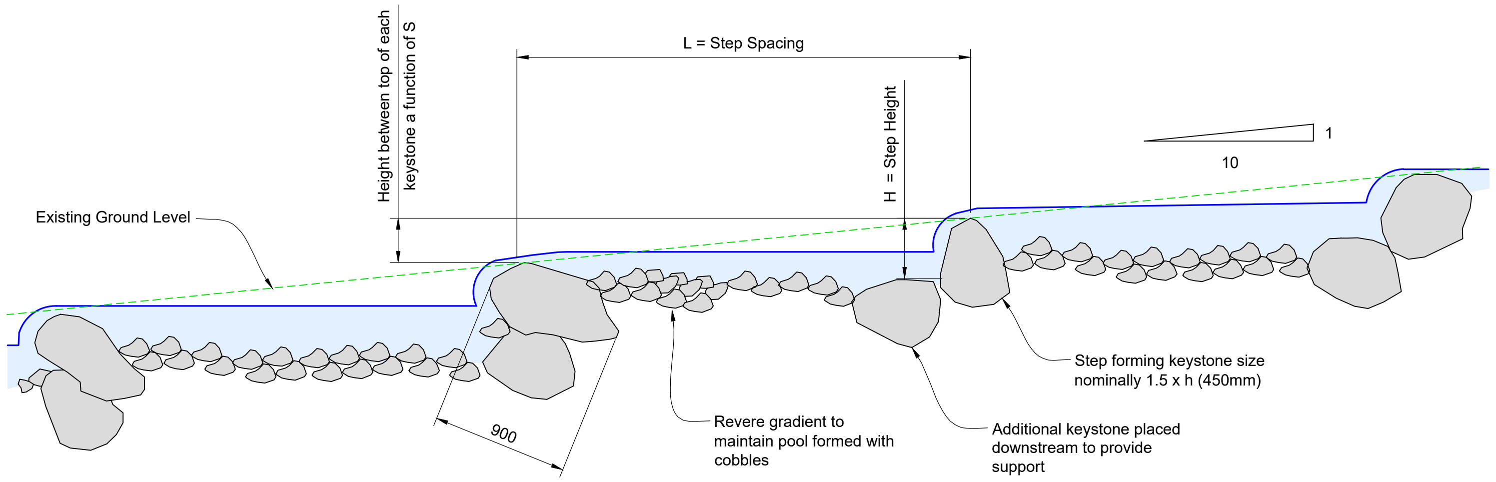
1. All levels are in metres above ordnance datum (mAOD).
2. All dimensions are in millimeters unless otherwise noted.
3. Please refer to CEMP for details of environmental protection measures (e.g. temporary erosion control, sediment traps, settlement lagoons, silt curtains). The works would be supervised by an Environmental Clerk of Works.
4. For proposed structure of sediment management plan refer to geomorphology report.
5. Climate change uplift for peak flows calculated in accordance with "SEPA's Climate change allowance for flood risk assessment in land use planning Version 5".
6. Resting pools shown indicatively on aqueduct plan. Final location to be agreed with an experienced fish ecologist at the detailed design stage.
7. Aqueduct channel substrates would be formed using natural sediments local to the system, to provide a well-graded mix of sediment appropriate to the energy regime of a stepped pool channel.
8. CCTV coverage at the confluence of existing burn and channel would will provide real time monitoring of flow and sediment conditions.

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 0.75m Wide Footpath & Catchwater
Cut-off Ditch at Leamhain
1:50 @ A3



Typical Cascade Detail
Pitridh Aqueduct Overflow and Leamhain
Catchwater Ditch and Moy Spillway Channel
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
P1	02.02.24	MW	FOR PLANNING	DT	GMcG

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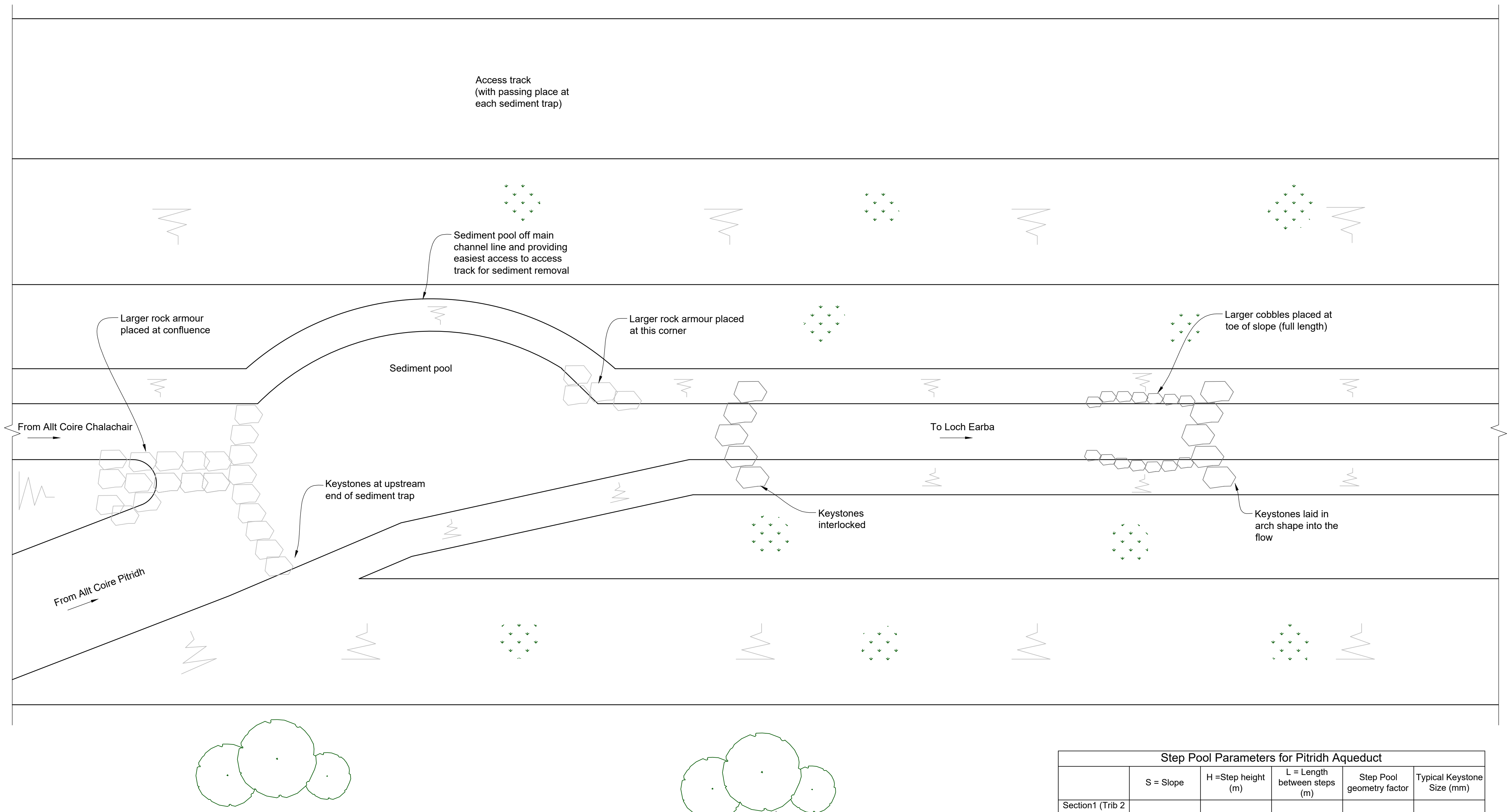
PROJECT
PROPOSED EARBA PSH

TITLE
PITRIDH AQUEDUCT DETAILS - SHEET 2
FIGURE 2.21.2

SIZE	SCALE AT A3	STATUS
A3	1:50	PLANNING

DRAWING NUMBER	REVISION
EAR/GEL/296	P2

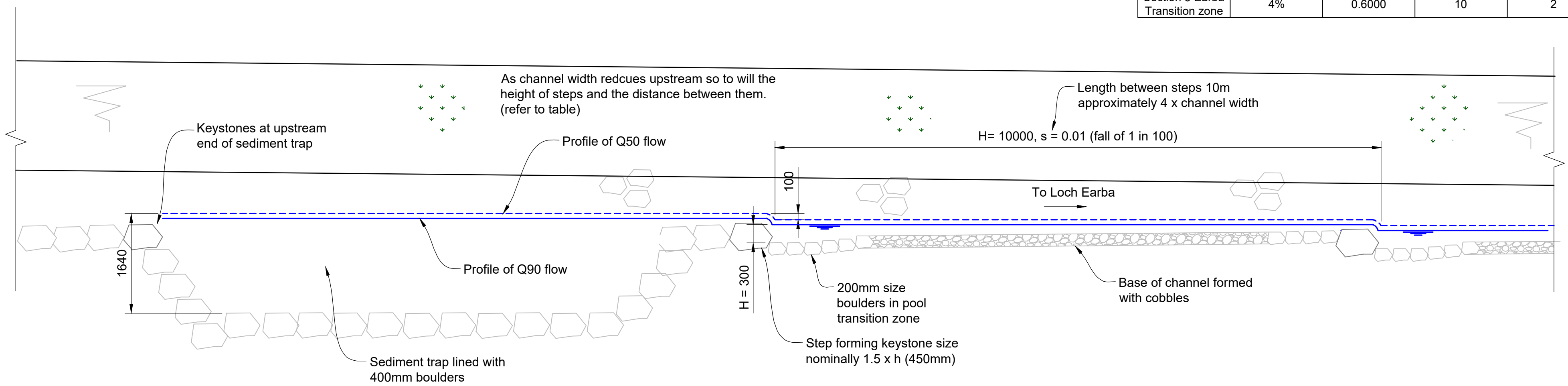


Plan on confluence of Allt Coire Pitridh to Pitridh Aqueduct

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



0 1.25m 2.5m

Section on confluence of Allt Coire Pitridh to Pitridh Aqueduct

1:100 @ A3

IF IN DOUBT - ASK

NOTES

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4. For proposed structure of sediment management plan refer to geomorphology report.
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6. Resting pools shown indicatively on aqueduct plan. Final location to be agreed with an experienced fish ecologist at the detailed design stage.
7. Aqueduct channel substrates would be formed using natural sediments local to the system, to provide a well-graded mix of sediment appropriate to the energy regime of a stepped pool channel.
8. CCTV coverage at the confluence of existing burn and channel would will provide real time monitoring of flow and sediment conditions.

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

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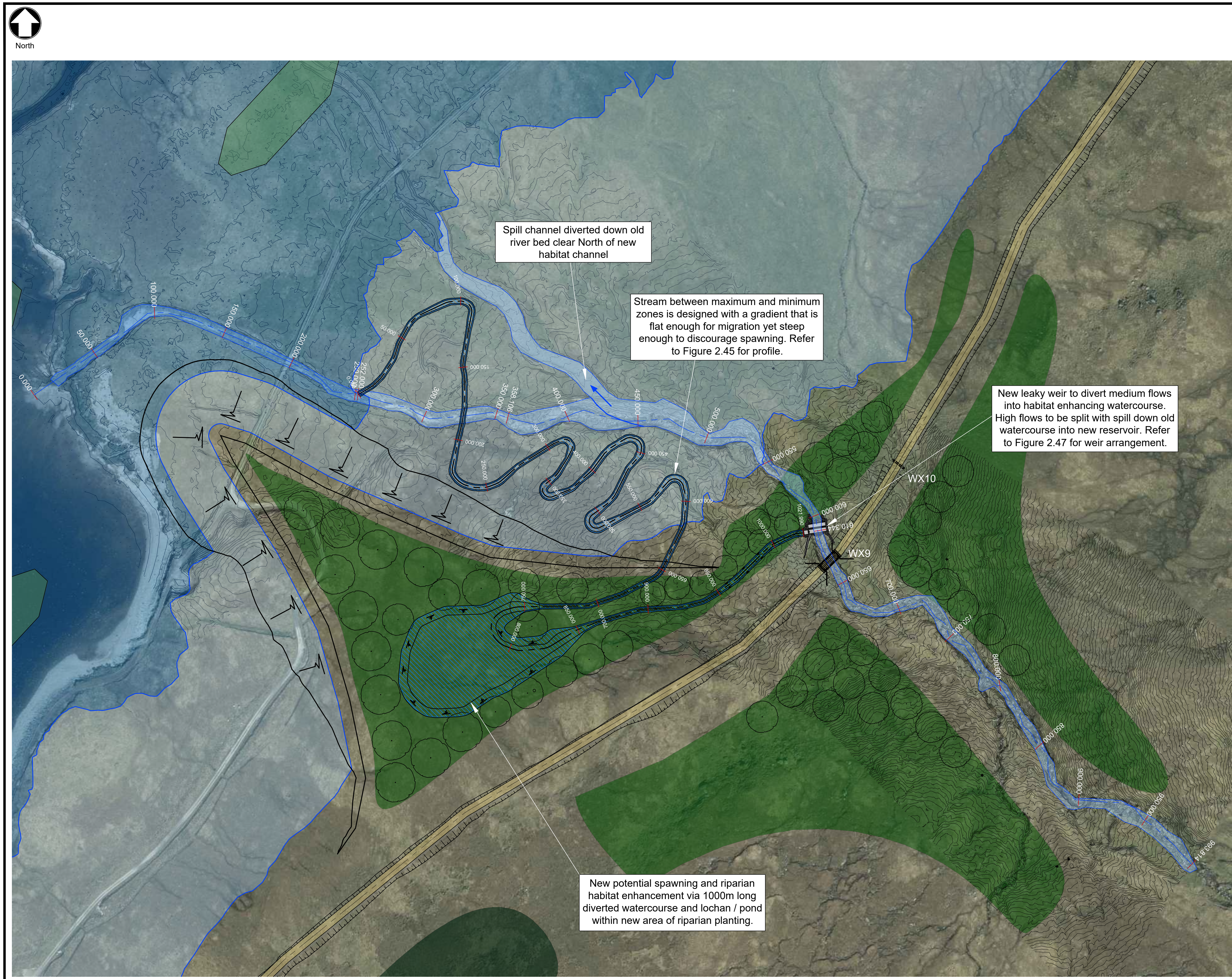
PROJECT
PROPOSED
EARBA PSH

TITLE
PITRIDH AQUEDUCT
DETAILS - SHEET 3
FIGURE 2.21.3

SIZE	SCALE AT A3	STATUS
A3	1:100	PLANNING

DRAWING NUMBER	REVISION
EAR/GEL/297	P1



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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TITLE
MOY BURN
HABITAT ENHANCEMENT WORKS
AREA PLAN - FIGURE 2.44.1

SIZE	SCALE AT A3	STATUS
A3	1:2500	PRELIMINARY

DRAWING NUMBER	REVISION
EAR/GEL/240	P2