Appendix 8.3 – Fish Surveys and Technical Reporting

FISH SURVEYS AND TECHNICAL REPORTING 2022

CRUACHAN 2

DRAX GENERATION ENTERPRISE LTD

2/05/2022

Gavia Environmental

Inveralmond Business Centre
Auld Bond Road
Perth
PH1 3FX
01738 646 741

54, Cook Street
Glasgow
G5 8JQ
0141 264 2891

Report prepared for	Applied Ecology Ltd Hillington Park Innovation Centre, 1 Ainslie Road Glasgow G52 4RU
Project name	Cruachan 2
Project & Report number	P21273/R1/v1.0
Prepared by	Paul Fraser
Approved by	Vince Smith

Revision History

Revision	Date	Comments	Reviewed	Approved
1.0	18/1/22	Issued for Client Comments	MH/PF	
2.0	16/5/22	Final	MH/AT	VS

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

Page Intentionally Left Blank

Contents

1 Introduction

Gavia Environmental Ltd. ('GEL') was commissioned by DRAX GENERATION ENTERPRISE Ltd ('the Client') to undertake fish population, aquatic macrophyte, macro-invertebrate, and fish habitat surveys on a section of shoreline at Loch Awe and Cruachan Reservoir.

The survey area was located at NN 07902 26700 and NN 08117 28629, approximately 11 kilometres (km) west of Dalmally in Argyll and Bute.

This report provides details of freshwater ecology surveys undertaken on the site between October 2022 – December 2022, including the methods used to collect primary and secondary data relating to freshwater features on or near to the site, a description of the survey results and an evaluation of the implications of these findings for the Development. These data will be used in the EcIA presented in Chapter 8 (Ecology) of the Environmental Impact Assessment Report (EIAR) for the Proposed Development.

1.1 Background/ Rationale

Drax has proposed to develop an additional hydro-storage power station adjacent to the existing Cruachan Pumped Storage Scheme. The new 600-megawatt (MW) power station will be located inside Ben Cruachan to the east of the existing power station. The existing Cruachan Reservoir, which can store 2.4 billion gallons of water, and has the capacity to serve both power stations. The new power station would increase the site's total capacity to 1.04-gigawatts (GW). The new power station would be built within a hollowed-out cavern inside Ben Cruachan, which would require the excavation of over a million tonnes of rock.

The development parameters have yet to be finalised; however, it is likely to be situated close to the existing Cruachan Power Station on the north side of Loch Awe. The Cruachan Reservoir and existing dam are located high within Coire Cruachan and are accessed by a private road.

The development will involve building a new inlet/outlet at Cruachan Reservoir, a new turbine hall within the Ben Cruachan, and a new outlet into Loch Awe. Therefore, the main impacts relate to the drawdown of the reservoir during the construction of the inlet/outlet pipe. In addition, the impact of the proposed building of a jetty in Loch Awe to facilitate the construction of a new inlet/outlet must be reviewed.

The client's request for survey was based on the findings and recommendations (Section 5) of previous survey report completed by Arcus Consulting (January 2018) *Cruachan Power Station Fisheries Habitat & Fish Fauna.* Gavia Environmental Limited initially proposed to conduct destructive sampling (gill netting) as part of these studies of fish populations, however these were discounted by the client team and the approach modified to assess spawning habitat potential and electric fishing surveys of the marginal areas of the lochs.

This was agreed and commissioned prior to feedback from the consultation responses detailed below.

The initial consultation responses received from Consultees and Stakeholders included the need to complete fish, invertebrate, and macrophyte surveys to inform the proposed development as the Cruachan Pumped Storage 2 (Project) has the potential to impact fish, macrophytes (higher plants) and invertebrate assemblages, due to the movement and regulation of water.

Consequently, aquatic field surveys were undertaken to investigate the habitat potential and fish, macrophyte, and invertebrate populations present within the reservoir and in the area of the intake on Loch Awe.

Given the above, the following nature conservation features were considered as part of this report.

1.1.1 Nature Conservation Features

1.1.1.1 Arctic Charr

Desk study research has identified the potential for Arctic charr (*Salvelinus alpinus*) within Loch Awe and because of water being pumped from Loch Awe, there is also an Arctic charr population located in the Cruachan Reservoir, some 300 m above (Maitland, 1990). Arctic charr are found within 5 km of the Cruachan Reservoir as highlighted by NBN Atlas. Four records have been documented and verified. However, these are within Loch Awe and not the reservoir itself. Each Record has a CC-BY license and is available for commercial use.

The Arctic charr is a salmonid fish, closely related to Brown trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) and a species that has been subject to population decline in the UK since 1990. Factors such as: acidification, nutrient enrichment, water level fluctuations/abstractions, the introduction of competitive fish, e.g., roach (*Rutilus rutilus*) and pike (*Esox Lucius)*; as well as climate change have all been proposed as causal factors.

The Arctic charr is primarily a still-water species (although occasionally occurring in rivers) across Europe, Asia and North America. Scotland is a stronghold for Arctic charr with approximately 258 resident populations recorded in Scottish freshwater lochs (Maitland *et al*. 2007). All Scottish Arctic charr populations are solely freshwater residents. The Arctic charr is listed in the UK Post 2010 Biodiversity Framework and the Scottish Biodiversity List as a 'Priority Species' (JNCC and Defra, 2012).

Arctic charr show polymorphism across Scotland; with two to three different forms noted by research; with the number of morphs present depending upon the loch itself, for example Loch Rannoch has all three forms, whilst other lochs only have two.

In Scotland, Arctic charr usually reproduce in October/November; the three different forms of Arctic charr display different spawning strategies. Arctic charr typically spawn over gravel-sized substrates, but spawning preference shows plasticity, with spawning occurring over a range of substrate sizes from coarse sand to boulders interspaced with gravel (Johnson, 1980). In Scotland, studies at Loch Coulin have shown that Arctic charr spawn over a mixture of gravel, sand, and silt; whilst at Loch Moy charr spawn in the silty inlet approximately 400 m from the loch. At Loch Rannoch, Arctic charr are present in multiple forms. The planktivorous form of Arctic charr are noted to spawn along the shores of the main loch at depth of 2-10 m. Whilst the benthic form of Arctic charr was observed to spawn in the River Gaur and Dall Burn and at varying depths (Adams, 1998).

There is a favouring towards clean, well-oxygenated, gravel and pebble-sized substrates, but they will also use coarser substrates. Egg incubation time to hatching varies with water temperature but may take two to three months.

1.1.1.2 Brook Lamprey

A population of Brook Lamprey (*Lampetra planeri*), another UK BAP and Scottish Biodiversity List 'Priority Species' species, is also found in the upper reservoir. The lamprey is a primitive freshwater fish, and at Cruachan Reservoir, it is present at an upper extent of its northern range (Scottish Power, 2010). The nearest record of brook lamprey is within a 5 km (kilometre) distance from Cruachan Reservoir but not the reservoir itself. This was recorded in 1981 and is documented on a CC-BY commercial use license on NBN Atlas.

Unlike some species of lamprey, adult brook lamprey do not migrate to the sea and do not have a parasitic phase. This freshwater species lives in small streams, rivers, and lakes with clean gravel beds to spawn in and silt or sand for the larvae. During the spawning time, adult brook lampreys do not feed. Brook lampreys spawn in spring and summer in shallow areas of streams and sometimes lakes in gravel close to the soft sediment in which they were previously resident. Both males and females create pits by removing small rocks with their mouths and fanning smaller particles with their tails. The male and female deposit sperm and eggs, simultaneously while intertwined, into the nest. Adult brook lamprey spawn in small groups and die soon after spawning (EOL, 2021).

The eggs of brook lamprey hatch within a few days, after which the young larvae bury themselves in soft sediment with only the mouth protruding. The young lampreys are blind filter feeders, feeding on detritus and other organic matter for three to five years before maturing. After spending four years as ammocoetes (larva), these lampreys metamorphose to adults in the fall and spawn the following spring. This process is complete after the maturation of the gonads. Eyes and suction disk also develop during this time, while the intestinal tract degenerates and loses its function. The full transformation can take up to a year (EOL, 2021).

It is perceived that the UK brook lamprey has been affected long-term by pollution, river engineering works and changes in land use. Consequently, actions plans have been produced to guide their conservation (EOL, 2021). It is currently listed on Annex III of the Bern Convention and Annex II of the EU Habitats Directive.

1.1.1.3 European Eel

A total of six documented records of the European eel (*Anguilla Anguilla L.*) have been confirmed within 5km of the Cruachan Reservoir.

The European eel (*Anguilla anguilla L.*) is a catadromous fish species that spawns in the Sargasso Sea and spends a large proportion of its life in UK freshwaters (De Meyer *et al*., 2015). Although once highly abundant, a sharp decline in (glass-eel) juvenile recruitment by 90-99% since the 1980's has driven the species to the verge of extinction (Verhelst *et al.*, 2018). Consequently, the European eel is now listed on the IUCN Red List of Threatened Species as “Critically Endangered”, just one level above “Extinct in the Wild” (Verhelst *et al*., 2018).

The rapid decline of European eel stock over the last 30 years has been attributed to a variety of anthropogenic threats affecting different stages of the eel life cycle (Bevacqua *et al.*, 2015). A major pressure facing European eel are barriers to migration, which includes mortality by hydropower turbines preventing completion of their life cycle (Jacoby *et al.*, 2015). Across Europe, there are over 24,000 hydropower plants, with this number set to rise in the future; each of these inhibits upstream movement of juvenile eels and the downstream migration of adult eels (Van der Meer, 2012).

To prevent further declines and promote recovery of European eel populations, the European Commission created a framework in 2007 (EC 1100/2007), requiring member states to implement eel management plans designed to safeguard the species from anthropogenic threats (Stein *et al.*, 2016). Unfortunately, post evaluations in 2012 and 2015 have revealed that most participating countries have not reached their intended objectives, with no improvement on eel recovery and little reduction in mortality (Dekker, 2016).

The European eel is listed in the UK Post 2010 Biodiversity Framework and the Scottish Biodiversity List as a ‘Priority Species’ (JNCC and Defra, 2012).

1.1.1.4 Aquatic Invertebrates

Although aquatic invertebrates play key roles within freshwater habitats, the aquatic invertebrate community assemblages of Loch Awe and Cruachan Reservoir have not been well studied.

2 Project Methodology

The following surveys were undertaken at Cruachan Reservoir and Loch Awe within the location of the Site illustrated in Figure 1 and Figure 2. Surveys were undertaken for aquatic invertebrates, fish populations, fish habitat, and macrophytes and the survey areas for these are illustrated in Figures 3-11 respectively.

3 Aquatic Invertebrate Surveys

3.1 Methodology

To collect aquatic macro-invertebrates, a combination of 'kick' sampling and 'sweep' sampling were deployed (Figure 3). Kick sampling was utilised in the inflowing burns surrounding Cruachan Reservoir. This is the standard method used when working in lotic water systems such as rivers less than 1m in depth, as the flow of water carries the invertebrates into the samplers' pond net after disturbance of the substratum. In lentic water systems such as those found in Cruachan Reservoir and Loch Awe, sweep sampling is the preferred method of aquatic macro-invertebrate sampling. This relies on a disturbance of the substrate and then a sweeping like motion in a figure of eight of the pond net through the water column to collect the sample (Chadd, 2010).

The use of macro-invertebrates as indicators of water quality is an established technique and the standard method employed by Environmental Regulators such as the Scottish Environmental Protection Agency (SEPA) and the Environment Agency in England and Wales.

The method is based on niche habitat requirements of different macro-invertebrate groups and their tolerance of pollution, and therefore changes in the chemical and physical nature of loch edge habitat or riverine will be reflected by changes in the composition of aquatic macro-invertebrate populations. The method is most commonly used to assess/monitor pollution levels in rivers and streams and is also used for the sampling of the shoreline of loch margins.

The pollution tolerance of each invertebrate family is largely reflected in its presence or absence. A typical example is a tolerance of the crustacean *(Asellus aquaticus*) water hog-louse to organic pollution, such that it can populate locations unsuitable for other species such as another crustacean species, *Gammarus pulex*. These differences in the sensitivity of different groups to environmental perturbation mean that by annually monitoring the invertebrate population composition at a site of interest, it is possible to infer deterioration or improvement in water quality.

To simplify the analysis, a widely accepted scoring system has been devised whereby each family of aquatic macro-invertebrates is allocated a score based on its pollution tolerance. For a given population at a given time, the scores can be used to calculate a single index that summarises the composition of a macroinvertebrate population. By establishing this index annually for a given site, it is possible to monitor changes in water quality.

The use of macro-invertebrate populations to monitor water quality is often preferable to monitoring changes in water chemistry as invertebrates integrate the effects of changes in water quality over time, whereas the chemical composition of a watercourse may fluctuate widely according to the timing of external influences.

In interpreting the causes of changes in invertebrate populations, it is important to separate the potential effects of anthropogenic changes, such as pollution, from the naturally arising effects of changes in the physical nature of watercourses such as water levels, flow rates, and substrate type, all of which are important factors determining the composition of aquatic invertebrate populations.

Five invertebrate surveys were utilised around the margins of Loch Awe and Cruachan Reservoir, utilising a sweep sample methodology (Figures 3 and 4). Additionally, kick sampling methodology was deployed in four of the 10 watercourses flowing into Cruachan Reservoir (Figure 5). This was due to steep gradients and safety concerns within the study area. These kick samples were performed to determine the different families/species and abundance of aquatic invertebrates.

Samples from the inflowing watercourses were taken using a standard 3-minute kick sampling technique, followed by a 1-minute surface sweep and a 1-minute hand search. The 5 marginal sweep samples at each waterbody were based on 3- minute surface sweeps and 1-minute hand searches.

Samples were live sorted and then fixed and processed off-site and identified to species level where practicable to do so by an expert in freshwater macro-invertebrate identification.

3.2 Results

In total, 10 survey sites were investigated for the suitability of performing kick samples to collect Aquatic Invertebrates. Moreover, marginal areas on both Loch Awe and Cruachan Reservoir were examined for their appropriateness for performing sweep samples.

Overall, four kick samples were undertaken on the inflowing burns leading to Cruachan Reservoir. This was to ascertain the families and abundance of aquatic invertebrates. Where possible, invertebrates were identified to species level where practical to do so.

Additionally, each water body was allocated five sweep samples each. This was in line with the initial proposal methodology. The five sweep samples were utilised around the margins of Loch Awe and Cruachan Reservoir, respectively, in areas suitable for safe access and the ability to support aquatic invertebrates. In Cruachan Reservoir, safe access was permitted at the north end, as well as some shallow margins on both the east and west side of the reservoir. The habitat in Cruachan Reservoir was predominantly a substrate of peat with a layer of fine sand sitting atop (Figure 16). Marginal areas that were accessible contained large boulders and water depths greater than 1m (Figure 17)

In Loch Awe, sweep samples were taken in close proximity to the proposed development and where access could be granted. Three sites were collected to the west of the current power station, and another two were collected at eastern locations near the current power station. The habitat available at the western sweep samples was chiefly composed of reclaimed land, which comprised of large boulders and depths of water greater than 1m (Figure 18). The habitat located at the eastern sweep sample sites were again constructed of reclaimed land and featured depths greater than 1m (Figure 19).

3.2.1 Sweep Sample Survey

Table 1 below presents the results from the sweep sample survey sites as either family/abundance, species/abundance. Where possible, aquatic invertebrates within the sweep samples were identified to species level to give further detail.

In Cruachan Reservoir, only four family groups of invertebrates were present, with Chironomidae (nonbiting midge) being the most abundant of the families, with 30 individual records.

In Loch Awe, four family groups of invertebrates were documented, with Oligochaeta (aquatic worms) being the most abundant, with 24 individuals logged. Additionally, 22 accounts of Chironomidae were observed in the Loch Awe sweep samples.

The sweep samples recovered from Cruachan Reservoir contained four individual species, with *Gammarus sp.* juvenile (freshwater shrimp) being the most abundant with three verified individuals. The sweep samples retrieved from Loch Awe included seven different species, with *Gammarus sp.* juvenile being the most abundant, with nine records logged.

Table 1: Aquatic Invertebrate Sweep Samples

Site	Location	Invertebrate Family and Abundance	Invertebrate Species and Abundance
Cruachan Reservoir Sweep Site 1	*NN 08214 29110*	*Oligochaeta – 1 -Aquatic worms*	*Gammarus sp. juvenile – 2 -Freshwater shrimp* *Sialis lutaria – 1 -Alderfly*
Cruachan Reservoir Sweep Site 2	*NN 08341 29191*	*Oligochaeta – 2*	*Gammarus sp. juvenile – 1*

Site	Location	Invertebrate Family and Abundance	Invertebrate Species and Abundance
		Chironomidae – 16 -Non-biting midge	
Cruachan Reservoir Sweep Site 3	*NN 08398 29182*	*Psychodidae – 1 -Drain fly* *Chironomidae -7* *Ostracoda – 2 – Seed shrimp*	*N/A*
Cruachan Reservoir Sweep Site 4	*NN 08478 29030*	*Chironomidae - 1*	*Hydroptila sp. – 1 - Microcaddis fly*
Cruachan Reservoir Sweep Site 5	*NN 08294 29170*	*Chironomidae - 6*	*(Limnephilidae) indeterminate -1 - Caddisfly*
Loch Awe Sweep Site 1	*NN 07740 26810*	*Oligochaeta – 1* *Ceratopogonidae – 1 - Biting midge* *Chironomidae – 2* *Ostracoda - 2*	*(Limnephilidae) indeterminate -1*
Loch Awe Sweep Site 2	*NN 07697 26892*	*Oligochaeta – 8*	*Gammarus sp. juvenile – 6* *Caenis luctuosa grp – 1 - Mayfly* *Sericostoma personatum - 1*
Loch Awe Sweep Site 3	*NN 08669 26385*	*Oligochaeta – 9* *Chironomidae - 14*	*Gammarus sp. juvenile – 1* *Sericostoma personatum – 1 -Caddisfly*
Loch Awe Sweep Site 4	*NN 08945 26263*	*Oligochaeta – 6* *Chironomidae - 4*	*Gammarus sp. juvenile – 2* *Nebrioporus elegans – 2 - Water beetle* *Hydroptila sp – 1 - Microcaddis fly* *Lepidostoma hirtum – 4 - Caddisfly*
Loch Awe Sweep Site 5	*NN 07977 26686*	*Chironomidae - 2*	*Lepidostoma hirtum – 1* *(Limnephilidae) indeterminate -1*

3.2.2 Kick Sample Survey

Table 2 below displays the results from the surveys.

The kick samples displayed six families of invertebrates, with Chironomidae being the most abundant, with 32 records. Six separate species were identified within the kick samples, with Leuctra sp. (a species of stonefly) being the most abundant with six observations.

Table 2: Aquatic Invertebrate Kick Samples

Site	Location	Invertebrate Family and Abundance	Invertebrate Species and Abundance	WHPT SCORE
Cruachan Reservoir Kick Sample Site 1	*NN 07914 28776*	*Oligochaeta -1 -Aquatic worm* *Chironomidae – 6 -Non biting midge* *(Limnephilidae) indeterminate -1*	*Leuctra sp. – 4 - Stonefly* *Plectrocnemia conspersa – 2 - Caddisfly*	*5.64*
Cruachan Reservoir Kick Sample Site 2	*NN 07952 28834*	*Chironomidae – 13* *(Limnephilidae) indeterminate -1 - Caddisfly*	*Gammarus sp. juvenile – 2 -Freshwater shrimp* *Nebrioporus elegans – 1 – Water beetle* *Eloeophila sp – 2 - Cranefly*	*4.26*
Cruachan Reservoir Kick Sample Site 3	*NN 08031 29021*	*Oligochaeta – 4* *Chironomidae -1* *Dytiscidae Larvae indet – 1 -Water beetle*	*Leuctra sp. – 1*	*4.65*
Cruachan Reservoir Kick Sample Site 4	*NN 08195 29104*	*Oligochaeta – 2* *Ceratopogonidae – 1 - Biting midge* *Chironomidae – 12* Ostracoda – 1 – Seed shrimp *(Limnephilidae) indeterminate -1*	*Gammarus sp. juvenile – 2* *Leuctra sp. -1* *Elemis aenea – 2 -Water beetle* *Eloeophila sp. - 1*	*5.05*

3.3 Discussion

3.3.1 Sweep Samples

Sweep samples collected from Loch Awe produced four family groups and seven individual species. The taxa collected were mainly generalists with and the most abundant family group was that of Oligochaeta (aquatic & terrestrial worms). In addition, the sample also contained a large number of the family group Chironomidae (non-biting midge).

Aquatic oligochaetes are benthic dwellers, occupying the sediments and decaying organic matter of most river and lake habitats, where they play a substantial eukaryotic role in decomposition. Most of these worms are adapted to live in sediments ranging from sand to mud. They can be found in pockets of such sediments in stony habitats as well as in lowland rivers, lakes, and ponds where soft substrates are the norm. In biotic indices, this family scores relatively low when looking at weighted abundance and can produce negative scores if high abundances are contained within a sample. This indicates that the family are tolerant of pollution.

Chironomidae are responsible for most of the richness and abundance of aquatic communities, especially in naturally poor environments and are generally considered a pollution resistant group (Molineri *et al.*, 2020). In biomonitoring, a rather impoverished benthic community, dominated by this family, is generally attributed to bad water quality (Raunio *et al.*, 2007). This is reflected in biotic indices such as the WHPT (Walley Hawkes Paisley Trigg) biotic index which produces low scores and even negative scores based on their weighted abundance within a sample. They inhabit all types of permanent and temporary aquatic habitats, and a few species inhabit semiaquatic or terrestrial habitats. Larvae are often the dominant insects in the profundal and sublittoral zones of lakes. Larvae of most species of Chironomidae are quite tolerant of lowered levels of dissolved oxygen; some can survive in areas where oxygen levels are so low that oxygen cannot be detected. Such species are usually red in colour and contain a haemoglobin like pigment that retains oxygen. These species may become abundant in organically polluted areas of lakes or streams (Pinder, 1986).

Both family groups are likely to be the most prolific within the Loch Awe samples based on where the samples were taken. The areas were marginal and are likely to experience periodic episodes of dewatering. Furthermore, as the areas surveyed are close to the shoreline, they contained an abundance of organic debris which would provide suitable habitat for both family groups.

The samples collected from Cruachan Reservoir revealed four family groups and four species of aquatic invertebrates. As with the results from Loch Awe, the family of Chironomidae was present in large numbers and was the dominant family group for this sample area. The likely reason for this is because of the habitat characteristics of the areas which were sampled, and the fluctuating water levels on the reservoir.

No species of nature conservation interest were noted from the sampling conducted. Of the species recorded, they were common and widespread taxa, typical of a range of habitat types. In the sweep samples the species composition was that of marginal and lotic environments. Species such as *Sericostoma personatum* are widespread throughout the UK and lake shores exposed to wave action with stony substrate (Elliot, 1969). Beetles were also recorded including the *Nebrioporous elegans* which is commonly noted in a range of habitats. The Small Silver Sedge (*Lepidostoma hirtum*) a species of caddisfly was recorded and is widespread in the north of the UK within habitats such as lakes with stony substrate. *Caenis luctuosa* is a species of small squaregilled mayfly which frequents margins of rivers and lake shores in the UK.

3.3.2 Kick Samples

Again, Chironomidae was the most abundant family, with 32 records observed. As previously mentioned, Chironomidae are responsible for most of the abundance and richness of aquatic communities, therefore their presence is to be expected. Additionally, the edges of these shallow burns will likely have similar characteristics to the marginal areas of Loch Awe and Cruachan Reservoir. No species of nature conservation interest were noted from the sampling conducted.

Of the species recorded, they were common and widespread taxa, typical of a range of habitat types. In terms of species, *Leuctra sp.* (species of stonefly belonging to the genus Leuctridae) was the most abundant across the kick samples. Compared with the sweep samples taking in the marginal areas of both waterbodies, the inflowing burns had faster flow, shallower depths, and would have higher levels of oxygen. These are all typical habitat requirements of stonefly nymphs which require cool, clean, flowing waters with relatively high oxygen concentrations. They are also very sensitive to pollution and act as indicators of good water quality. This can be seen in their high weighted abundance scores in the WHPT biotic index.

In the kick samples the species composition was typical of upland burns, with predatory caseless caddisfly species such as *Plectrocnemia conspersa* noted along with stonefly *Leuctra sp.* being common in small flowing and oxygen rich upland streams and in the case of *P. conspersa* acidic. The short-palped cranefly of the genus *Eloephila* suggests that mosses and liverworts or decaying woody debris, the main food source for this genus of cranefly, are present and this cranefly is typically associated with edge of streams habitats. Beetles were also recorded including *Nebrioporous elegans* which is commonly noted in a range of habitats in Southern Scotland but is slightly rarer in habitats noted in Argyll and Bute, but this species has been recorded as far north as Orkney. This species is eurytopic occurring in both still and running water in a wide range of habitats from running water to ponds and lakes. *Elmis aenea* another beetle species noted, is also typical of riffle habitats within small burns. The freshwater shrimp from the genus *Gammarus* was also recorded in the kick samples and would also indicate the presence of oxygen rich flowing or standing water.

3.4 Conclusions and Recommendations

Aquatic Invertebrate surveys were undertaken on both Loch Awe and Cruachan Reservoir utilising kick and sweep sample methodology. However, these surveys were limited to safe marginal areas within both waterbodies and four of the inflowing burns of Cruachan Reservoir. Consequently, there is the potential that a small proportion of the available invertebrate species in both water bodies has been sampled. Moreover, the samples were collected during September 2021 and therefore provide a snapshot in time of the potential invertebrate species present.

4 Timed Fish Population Surveys

4.1 Methodology

As a result of depths shelving quickly from the marginal areas and the difficulty of electrofishing at depth, electrofishing surveys were kept to the margins of both Loch Awe and Cruachan Reservoir (Figures 6, 7, 12, 13).

Fish population surveys were conducted using time delineated methodology in line with the Scottish Fisheries Co-ordination Centre (SFCC) protocol (SFCC, 2014). Timed surveys operate on a catch per unit effort basis and require a single run of five minutes of fishing effort, which excluded any time the anode was not switched on in the water, whilst surveyors were wading or when fish were being transferred to holding buckets.

Timed fishing does not provide absolute values for fish densities, but rather it provides a snapshot of presence/absence of fish species assemblages.

Target species considered were brown trout (*Salmo trutta*), Arctic charr (*Salvelinus alpinus*) and European eel (*Anguilla anguilla*). Invasive non-native fish species (INNS) were also noted if identified during the surveys as INNS may have a negative impact on Arctic charr populations due to predation and direct competitivity for spawning habitat.

4.2 Results

A total of eight timed fish population surveys were conducted across Loch Awe and Cruachan Reservoir. As previously mentioned, these were undertaken in areas with safe access and close to the shoreline due to steep shelving. As discussed above, the habitat in Loch Awe was reclaimed land with depths dropping beyond 1m within a small distance from the shoreline. Whilst the areas surveyed on Cruachan Reservoir changed dramatically in terms of water levels over consecutive days.

The results are displayed in Table 3 below and present the results for each water body and the species present.

Loch Awe's results revealed four freshwater fish species with European minnow (*Phoxinus phoxinus*) being the most abundant across the survey sites. Other fish species included European eel, brown trout, and European perch (*Perca fluviatilis*).

Results from Cruachan Reservoir revealed no fish species during the timed fish population surveys.

Table 3: Timed Fish Population Survey

Site	Location	Fish Species and Abundance	Notes
Loch Awe Site 1	*NN 07740 26810*	*European minnow – 4* *European eel – 1* *Brown trout - 1*	*Close to visitor centre.*
Loch Awe Site 2	*NN 08939 26250*	*Brown trout - 1*	
Loch Awe Site 3	*NN 07970 26695*	*European perch – 3* *European minnow – 2* *European eel - 2*	
Loch Awe Site 4	*NN 08667 26381*	*European minnow – 3* *European eel - 2*	
Cruachan Reservoir Site 1	*NN 08405 29163*	*N/A*	
Cruachan Reservoir Site 2	*NN 08487 28986*	*N/A*	
Cruachan Reservoir Site 3	*NN 08470 29019*	*N/A*	
Cruchan Reservoir Site 4	*NN 08428 29070*	*N/A*	

4.3 Discussion

In total four species of freshwater fish were identified from the surveys across Loch Awe. This included European minnow, European perch, European eel, and brown trout. This only represents a small number of species that can be found within Loch Awe. Species such as Atlantic salmon, pike (*Esox Lucius*), three-spined Stickleback (*Gasterosteus aculeatus*), and roach (*Rutilus rutilus*) have all been documented within Loch Awe.

As mentioned previously, the surveys were limited to marginal sections within Loch Awe and covered only a small area of the loch overall. However, these marginal areas and their habitat were uniform along the Proposed Development with the only limitation to their survey being safe access. Therefore, it could be assumed, that the aforementioned species detected in the surveys would also feature across similar habitat within other parts of the Proposed Development.

European eels utilise large cobbles and boulders as both refuge and ambush points, Three-spined stickleback prefer slower marginal waters with emerging vegetation, which they can use for nest building. European minnow will utilise shallow-marginal areas with slower flows and vegetation as refuge. Pike will also use these areas as ambush points if suitable vegetation is present and younger pike will seek refuge in this habitat.

Atlantic salmon may swim past the area close to the lower intake works and potentially young salmon may utilise the area near the lower intake works for refuge as was seen with their close relative the brown trout. Both species have similar habitat preferences.

The surveys conducted in Cruachan Reservoir revealed no freshwater fish species. This is likely due to the limitations on suitable areas to survey and the fluctuation water level and lack of control for survey purposes, rather than representing an absence of fish in these areas.

4.4 Conclusions and Recommendations

Surveys on both waterbodies were limited as a result of steep shelving and the effectiveness of electro-fishing at depth. Additionally, as water levels fluctuated on the reservoir, areas that had been previously submerged where then exposed, this means that surveys undertaken may be limited in their results.

A recommendation would be to carry out gill netting to exploit a larger survey area and to ascertain fish populations on both Loch Awe and Cruachan Reservoir. This would be beneficial, as it would inform the works of what mitigation processes they may have to put in place to safeguard fish species in both working areas.

It is also recommended that fish rescues be planned in both working areas. This would allow the area to be segregated and any fish contained within to be translocated to the main water body safely.

5 Fish Habitat & Aquatic Macrophyte Surveys

5.1 Methodology

Due to the size of Loch Awe and Cruachan Reservoir, a broad habitat assessment of the littoral zone within the site boundary and at suitable spawning locations around Cruachan Reservoir was undertaken.

The habitat survey was conducted by two experienced Ecologists using 10 perpendicular boat transects and 31 sampling points on Loch Awe and 19 transects and 55 sampling points on Cruachan Reservoir (Figures 10 and 11). The boat-based transects extended until depths exceeded 10m (the assumed maximum depth at which Arctic charr have been known to spawn) and/or a distance of over 100m from the shore was reached. The habitat assessment was based on that for Vendace (*Coregonus albula*) developed by Coyle and Adams (2011).

Depth and substrate were recorded at intervals along the transects until a depth of 10m had been exceeded, or the deepest point along the transect had been reached. Habitat was recorded using a Submertech HD spyball camera, and depths were obtained via a Speedtach Instruments handheld echo sounder.

Aquatic macrophyte surveys were conducted along the shoreline and photic zone of Loch Awe. The surveys were based on a standardised field survey approach for aquatic macrophyte surveys (JNCC, 2015) (Figure 9).

Wading surveys included one 100m sector along with suitable areas of shoreline in both Loch Awe and Cruachan Reservoir. Each sector contained five transects which were spaced at 20m intervals. The five transects each contained four sampling points at increasing water depths of 0.25m, 0.5m, 0.75m and >0.75m from the shoreline. Therefore, the 100m sectors contained 20 sapling points, each covering an area of $1m^2$. A bathyscope and grapnel were used to examine the species present at each sampling point. Additionally, a grapnel haul of 4m was undertaken parallel to the shore at increasing depths along each transect. At the end of each transect, a 4m grapnel haul was taken perpendicular to the shoreline.

At each $1m^2$ sampling point, the following data was collected:

a) All species present.

b) An estimate of total vegetation abundance (scoring 0-3).

c) An estimate of (non-charophyte) algal abundance (i.e., filamentous algae/blanket weed) (scoring 0-3).

The scoring of vegetation abundance was also collected and assigned as follows:

a) 0 – Absent (bare substrate)

b) 1 - <25% cover

c) 2 – 25 -75% cover

d) 3 - >75% cover

A strandline survey for washed-up plants was also conducted along with each 100m sector with presence/absence data recorded. The strandline sector was divided into 5 equal sections, and presence noted as 'S' if washed up and 'G' if growing at the water's edge.

5.2 Results

5.2.1 Fish Habitat Survey

The results from the survey indicate that substrate composition for potential salmonid spawning habitat is either unsuitable or sub-optimal. This is due to either the substrate type being too large, not containing enough spawning substrate or the presence of sand and silt (Table 4).

Table 4: Fish Habitat Survey - Loch Awe

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
1	*LA1A*	*2.7m*	*0*	*70*	*10*	*0*	*0*	*10*	*10*	*0*	*0*	*Unsuitable*
	LA1B	*11.3m*	*0*	*60*	*10*	*0*	*0*	*15*	*15*	*0*	*0*	*Unsuitable*
2	*LA2A*	*7.4m*	*0*	*70*	*10*	*0*	*0*	*10*	*10*	*0*	*0*	*Unsuitable*
	LA2B	*13.4m*	*0*	*60*	*10*	*0*	*0*	*15*	*15*	*0*	*0*	*Unsuitable*
	LA2C	*16.9m*	*0*	*40*	*0*	*0*	*0*	*30*	*30*	*0*	*0*	*Unsuitable*
3	*LA3A*	*1.7m*	*0*	*60*	*20*	*10*	*10*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	LA3B	*4.1m*	*0*	*50*	*25*	*10*	*5*	*5*	*5*	*0*	*0*	*Sub-Optimal*
	LA3C	*8.9m*	*0*	*40*	*20*	*10*	*0*	*15*	*15*	*0*	*0*	*Unsuitable*
	LA3D	*13.2m*	*0*	*0*	*10*	*10*	*0*	*30*	*50*	*0*	*0*	*Unsuitable*
4	*LA4A*	*1m*	*0*	*50*	*30*	*10*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	LA4B	*4.2m*	*0*	*30*	*30*	*0*	*0*	*20*	*20*	*0*	*0*	*Unsuitable*
	LA4C	*8.5m*	*0*	*30*	*0*	*0*	*0*	*25*	*45*	*0*	*0*	*Unsuitable*
	LA4D	*13.4m*	*0*	*20*	*0*	*0*	*0*	*30*	*50*	*0*	*0*	*Unsuitable*
5	*LA5A*	*1.9m*	*0*	*70*	*20*	*10*	*0*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	LA5B	*4.6m*	*0*	*65*	*15*	*0*	*0*	*10*	*10*	*0*	*0*	*Unsuitable*
	LA5C	*11m*	*0*	*30*	*0*	*0*	*0*	*35*	*35*	*0*	*0*	*Unsuitable*
6	*LA6A*	*3.8m*	*0*	*65*	*15*	*10*	*10*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	LA6B	*8.8m*	*0*	*55*	*15*	*5*	*5*	*10*	*10*	*0*	*0*	*Unsuitable*
	LA6C	*12m*	*0*	*30*	*0*	*0*	*0*	*20*	*40*	*0*	*0*	*Unsuitable*

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
7	*LA7A*	*3m*	*0*	*55*	*15*	*10*	*10*	*5*	*5*	*0*	*0*	*Sub-Optimal*
	LA7B	*8.2m*	*0*	*20*	*10*	*5*	*5*	*20*	*40*	*0*	*0*	*Unsuitable*
	LA7C	*12.4m*	*0*	*0*	*0*	*0*	*0*	*40*	*60*	*0*	*0*	*Unsuitable*
8	*LA8A*	*2.6m*	*0*	*65*	*20*	*15*	*5*	*5*	*0*	*0*	*0*	*Sub-optimal*
	LA8B	*5.6m*	*0*	*60*	*15*	*15*	*5*	*0*	*5*	*0*	*0*	*Sub-Optimal*
	LA8C	*10.2m*	*0*	*0*	*0*	*0*	*0*	*40*	*60*	*0*	*0*	*Unsuitable*
9	*LA9A*	*2.3m*	*0*	*60*	*30*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	LA9B	*6.4m*	*0*	*60*	*15*	*10*	*5*	*5*	*5*	*0*	*0*	*Sub-Optimal*
	LA9C	*11.2m*	*0*	*50*	*10*	*5*	*5*	*15*	*15*	*0*	*0*	*Unsuitable*
10	*LA10A*	*2.3m*	*0*	*70*	*15*	*5*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	LA10B	*7m*	*0*	*65*	*15*	*10*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	LA10C	*11.4m*	*0*	*60*	*10*	*5*	*5*	*10*	*10*	*0*	*0*	*Unsuitable*

The results from the survey indicate that substrate composition for potential salmonid spawning habitat is either unsuitable or sub-optimal. This is due to either the substrate type being too large, not containing enough spawning substrate or the presence of sand and silt (Table 5).

Table 5: Fish Habitat Survey – Cruachan Reservoir

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
1A	*CR1A1*	*1.8m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR1A2	*5m*	*0*	*60*	*20*	*10*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR1A3	*10.2m*	*0*	*0*	*10*	*5*	*5*	*30*	*40*	*0*	*0*	*Unsuitable*
3A	*CR3A1*	*1.9m*	*0*	*70*	*15*	*10*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR3A2	*5.3m*	*0*	*50*	*20*	*10*	*10*	*5*	*5*	*0*	*0*	*Sub-Optimal*
	CR3A3	*10.2m*	*0*	*40*	*30*	*20*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
6A	*CR6A1*	*1.8m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR6A2	*5.2m*	*0*	*65*	*20*	*10*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
	CR6A3	*10.1m*	*0*	*50*	*15*	*5*	*5*	*10*	*10*	*0*	*0*	*Unsuitable*
8A	*CR8A1*	*1.5m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR8A2	*5m*	*0*	*60*	*15*	*10*	*10*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR8A3	*10.4m*	*0*	*60*	*10*	*10*	*10*	*10*	*5*	*0*	*0*	*Sub-Optimal*
10A	*CR10A1*	*1.7m*	*0*	*70*	*20*	*10*	*0*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR10A2	*4.8m*	*0*	*60*	*40*	*0*	*0*	*0*	*0*	*0*	*0*	*Unsuitable*
	CR10A3	*10.6m*	*0*	*50*	*20*	*10*	*10*	*5*	*5*	*0*	*0*	*Sub-Optimal*
1B	*CR1B1*	*2.2m*	*20*	*30*	*15*	*15*	*20*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR1B2	*2.2m*	*20*	*30*	*15*	*15*	*20*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR1B3	*2.2m*	*20*	*30*	*15*	*15*	*20*	*0*	*0*	*0*	*0*	*Sub-Optimal*
2B	*CR2B1*	*2m*	*0*	*65*	*25*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR2B2	*4.8m*	*0*	*60*	*30*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR2B3	*10m*	*0*	*0*	*0*	*0*	*0*	*40*	*40*	*0*	*20*	*Unsuitable*
3B	*CR3B1*	*1.8m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR3B2	*5.4m*	*0*	*60*	*15*	*10*	*5*	*5*	*5*	*0*	*0*	*Sub-Optimal*
	CR3B3	*10m*	*0*	*10*	*10*	*5*	*5*	*30*	*30*	*0*	*0*	*Unsuitable*
4B	*CR4B1*	*2m*	*0*	*50*	*20*	*15*	*15*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR4B2	*6m*	*0*	*45*	*15*	*15*	*15*	*10*	*0*	*0*	*0*	*Sub-Optimal*
	CR4B3	*10.1m*	*0*	*20*	*10*	*0*	*0*	*30*	*40*	*0*	*0*	*Unsuitable*
5B	*CR5B1*	*1.3m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR5B2	*5.6m*	*0*	*65*	*15*	*10*	*10*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR5B3	*10.5m*	*0*	*30*	*10*	*0*	*0*	*30*	*30*	*0*	*0*	*Unsuitable*
6B	*CR6B1*	*2.6m*	*0*	*70*	*30*	*0*	*0*	*0*	*0*	*0*	*0*	*Unsuitable*
	CR6B2	*4.9m*	*0*	*60*	*25*	*10*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR6B3	*10.3m*	*0*	*20*	*15*	*0*	*0*	*20*	*35*	*0*	*10*	*Unsuitable*
7B	*CR7B1*	*2.3m*	*0*	*70*	*25*	*5*	*0*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR7B2	*5.2m*	*0*	*65*	*20*	*10*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
	CR7B3	*10m*	*0*	*50*	*30*	*15*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
8B	*CR8B1*	*2.6m*	*0*	*70*	*30*	*0*	*0*	*0*	*0*	*0*	*0*	*Unsuitable*
	CR8B2	*5.8m*	*0*	*60*	*25*	*15*	*0*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR8B3	*12.2m*	*0*	*5*	*5*	*0*	*0*	*40*	*50*	*0*	*0*	*Unsuitable*
9B	*CR9B1*	*2.3m*	*0*	*70*	*20*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR9B2	*5.3m*	*0*	*60*	*15*	*10*	*15*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR9B3	*10.2m*	*0*	*25*	*10*	*15*	*5*	*15*	*30*	*0*	*0*	*Unsuitable*
10B	*CR10B1*	*2.4m*	*60*	*30*	*10*	*0*	*0*	*0*	*0*	*0*	*0*	*Unsuitable*
	CR10B2	*4.9m*	*40*	*40*	*20*	*0*	*0*	*0*	*0*	*0*	*0*	*Unsuitable*
	CR10B3	*10m*	*0*	*40*	*15*	*10*	*10*	*15*	*10*	*0*	*0*	*Sub-Optimal*
1C	*CR1C1*	*1.9m*	*0*	*70*	*20*	*10*	*0*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR1C2	*4.5m*	*0*	*50*	*20*	*15*	*10*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR1C3	*10.2m*	*0*	*40*	*20*	*10*	*10*	*10*	*10*	*0*	*0*	*Sub-Optimal*
3C	*CR3C1*	*2.1m*	*0*	*50*	*20*	*15*	*10*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR3C2	*4.6m*	*0*	*60*	*20*	*10*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR3C3	*10m*	*0*	*20*	*20*	*40*	*10*	*5*	*5*	*0*	*0*	*Sub-Optimal*
4C	*CR4C1*	*1.2m*	*0*	*60*	*20*	*10*	*5*	*5*	*0*	*0*	*0*	*Sub-Optimal*
	CR4C2	*4.8m*	*0*	*50*	*35*	*10*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR4C3	*10m*	*0*	*40*	*30*	*20*	*10*	*0*	*0*	*0*	*0*	*Sub-Optimal*
5C	*CR5C1*	*2.1m*	*40*	*30*	*10*	*10*	*10*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR5C2	*5m*	*0*	*60*	*30*	*5*	*5*	*0*	*0*	*0*	*0*	*Sub-Optimal*
	CR5C3	*10m*	*0*	*10*	*10*	*10*	*10*	*30*	*30*	*0*	*0*	*Unsuitable*

5.2.2 Aquatic Macrophyte Survey

In total, one sector containing two transects was completed for aquatic macrophytes within Loch Awe (Figure 9). This was close to the lower intake works, where water levels dropped off quickly. Table 6 (Appendix B) below details the species identified from the survey, the vegetation score, and the algal abundance score for each sampling point.

A total of 12 species were recovered from the four sampling points:

European Brooklime (*Veronica beccabunga*) – This is a marginal aquatic perennial that grows in water up to 10cm deep.

Water mint (*Mentha aquatica*) - Water mint occurs in the shallow margins and channels of streams, rivers, pools, dikes, ditches, canals, wet meadows, marshes, and fens. If the plant grows in the water itself, it rises above the surface of the water. It generally occurs on mildly acidic to calcareous (it is common on soft limestone) mineral or peaty soils. Typically associated with permanently wet habitats adjacent to open water, often partially or wholly submerged.

Ivy-Leaved Crowfoot (*Ranunculus hederaceus*) - A small annual or short-lived perennial found at the edge of small water bodies and by the sheltered backwaters of rivers. It often grows on the cattle-poached edges of ponds, ditches, and streams, in wet gateways and on paths and tracks. It tolerates a broad range of pH and nutrient levels, including nitrophilous conditions.

Water Crowfoot (*Ranunculus aquatilis*) - This is an aquatic plant growing in mats on the surface of water. It has branching, thread-like underwater leaves and toothed floater leaves. In fast-flowing water, the floaters may not be grown. The flowers are white petaled with yellow centres and are held a centimetre or two above the water. The floater leaves are used as props for the flowers and are grown at the same time. It grows in shallow water in marshes, ponds, and ditches and at the edge of slow-flowing streams and sheltered lakes. It occurs chiefly in water which is eutrophic and at least mildly base-rich and is favoured by a degree of disturbance. Grows in muddy margins in water 15-60cm deep.

Bog Pondweed (*Potamogeton polygonifolius*) - This is an aquatic plant. It is found in shallow, nutrient-poor, usually, acid standing or running water, bogs, fens and occasionally ditches. In Britain and Ireland, this is one of the commonest pondweeds, occurring in almost any wet or semi-wet oligotrophic and/or acidic habitat so long as the flow is not too rapid. It may be found in lakes, slow-flowing rivers, ponds, ditches, seeps and among bog mosses. In lakes, it tends to occur in base-poor, oligotrophic waters, especially with a peaty substrate. Potamogeton can be marginal or deep-water aquatic perennials, with translucent submerged and leathery floating leaves and small spikes of inconspicuous flowers held below or just above water level. This rhizomatous perennial herb may grow as an aquatic in shallow water in lakes, pools, the backwaters of rivers, streams, and ditches, or in a dwarf, subterrestrial state in wet Sphagnum lawns or `brown moss` communities. It is usually restricted to acidic water, only rarely occurring in highly calcareous but nutrient-poor sites.

Curled Pondweed (*Potamogeton crispus*) - Curled pondweed is widespread and common across most of its native range, growing in standing and slow-flowing water, including small ponds and ditches. It is strictly a lowland plant and requires fine substrates in standing or slow-flowing calcareous water. However, it is tolerant of significant nutrient pollution, and this has allowed it to persist in intensively farmed areas where more sensitive pondweeds have declined. It grows in a wide range of mesotrophic or eutrophic waters. These include lakes, ponds, rivers, streams, canals, ditches, and disused mineral workings. It is more tolerant of eutrophication than most British *Potamogeton* species.

Bottle Sedge (*Carex rostrata*) - A rhizomatous perennial herb found in emergent stands on the edges of lakes and ponds, rivers, and streams, in ditches, swamps, fens and bog pools, wet meadows, flush-bogs on hillsides, sea-cliff flushes, wet dune-slacks, and alder (*Alnus glutinosa*) and Salix carr. It usually grows in oligotrophic or mesotrophic, acidic waters, though it also occurs in nutrient-poor calcareous conditions.

Small Pondweed (*Potamogeton pusillus*) – This is a species of aquatic plant found in standing and slow-flowing freshwater habitats throughout the Northern Hemisphere. Small pondweed grows in standing or slow-flowing water bodies such as ponds, lakes, ditches, slow-moving streams, and river backwaters. It is a lowland plant and requires calcareous water, with a marked preference for high nutrient levels, and may form extensive beds in favourable situations, growing with other nutrient-tolerant species. It is tolerant of turbid water and is a good colonist, often exploiting temporary or disturbed habitats such as livestock drinking ponds, canals, and ditches. In lakes, it is very tolerant of eutrophication and the resulting competition from phytoplankton and periphyton and is often one of the last submerged plants to disappear. Found in standing or slowly flowing water in sheltered lakes and reservoirs, ponds, rivers, canals, ditches and flooded mineral workings. It favours mesotrophic to eutrophic water and tolerates slightly brackish conditions.

Aquatic Bulbous Rush (*Juncus bulbosus (var. fluitans*)) - A very variable herb, ranging from tufted, terrestrial plants to submerged, floating aquatics, often rooting at the nodes and with proliferating flowers. It occurs in or by water and in open, often seasonally wet habitats, acidic to neutral soils.

Thamnobryum alopecurum – Moss species in the family Neckeracaeae. Riparian pleurocarps often adapt to periodic immersion and water shear by growing in atypical ways, and *T. alopecurum* is no different.

Water Moss (*Fontinalis antipyretica*) – A species of submerged aquatic moss belonging to the subclass Bryidae. It is found in both still and flowing freshwater. It occurs attached to the substrate in lakes and as floating masses in still water and may be cast upon beaches at the waterside. It thrives in shady positions and prefers acidic water.

Water Forget-Me-Not (*Myosotis scorpioides*) - The plant is usually found in damp or wet habitats, such as bogs, ponds, streams, ditches, fen, and rivers. Whilst it favours wet ground, it can survive submerged in water and often can form floating rafts. It is a stoloniferous or rhizomatous perennial herb found in damp or wet habitats, usually infertile, calcareous to mildly acidic soils. It is usually terrestrial, occurring by lakes, ponds, rivers, and streams, in marshes and in fens, but may sometimes be aquatic, forming submerged patches of floating rafts.

5.3 Discussion

In both Loch Awe and Cruachan Reservoir the substrate type and composition were deemed to be unsuitable and sub-optimal for the potential of salmonid spawning habitat. The main reasons for this were because the substrate was too large, did not contain enough suitable spawning substrate type, or the presence of sand and silt.

The availability of suitably sized substrate can impact the spawning success of salmonids in lakes and rivers (Kondolf and Wolman, 1993). The main spawning habitat requirements for Atlantic salmon and brown trout are well defined. Atlantic salmon require an uncompacted and well-oxygenated substrate with a size range of golf ball (pebble) to tennis ball (small cobble) size. Trout require smaller sized substrates with a size range down to gravel size (SFCC, 2007). Cobble, gravel, and pebble are between 2mm and 256mm in diameter. Favoured spawning sites of *S. salar* and *S. trutta* contain a substrate size ranging from 10mm -100mm in diameter (Ottaway *et al*., 1981; Chapman, 1988; Louhi *et al*., 2008). Arctic charr, are also known to normally spawn on a substrate comprised of mainly gravel (Johnson, 1980).

Substrate size is important as females need to be able to move most of the substrate in a spawning area to excavate a depression in the substrate to create a redd (Crisp, 2000). In both waterbodies, substrate type near the shoreline was predominantly in the size range of boulder and large cobbles. This would suggest that the substrate was not conducive to suitable salmonid spawning habitat as the substrate size was too large and did not contain enough of the correct substrate types to create a redd.

Conversely, substrate types such as sand and silt which are less than 2mm in diameter are referred to as 'fines.' If the substrate contains a high proportion of these fines, it can have deleterious effects on the incubation and survival of eggs contained within a redd (Armstrong *et al*., 2003). High content of fines within the substrate prevents sufficient permutation of oxygen into the interstitial spaces within the available spawning substrate and can prevent the removal of harmful metabolic waste, specifically ammonia (Crisp, 1996).

Across both waterbodies as depth increased, the substrate type became progressively finer and largely included sand, silt, or a combination of both. This in combination with increased depths, would indicate that the substrate is not suitable salmonid spawning habitat.

Despite the perceived lack of suitable salmonid spawning habitat, it has been documented that Arctic charr will also utilise areas that contain gravel, sand, and silt (Walker, 2006). Therefore, across both water bodies, the potential for suitable Arctic charr spawning habitat is potentially present. Conversely, the 2006 report by Walker does state that further studies are required to fully understand the physical and chemical conditions of Arctic charr spawning sites in Scotland.

Aquatic macrophyte surveys were limited to one area on Loch Awe due to safe access. However, within this area a total of 12 species were collected and identified. The main characteristics of the area surveyed was that it was shallow, close to the shoreline, large boulder substrate, was subject to wave action, and would experience fluctuating water levels in comparison to the rest of the Loch. This would potentially explain why many of the macrophyte species recovered during the survey are known to utilise shallow, marginal, and areas of low flow within lake habitats. In addition, the build-up of decaying organic material close to the shoreline provide suitable substrate for the macrophytes.

5.4 Conclusion and Recommendations

Results from the boat-based fish habitat surveys indicated that typical salmonid spawning habitat was unavailable in both Loch Awe and Cruachan Reservoir. Furthermore, with fluctuating water levels on Cruachan Reservoir, the areas being surveyed may experience a sequence of exposure and inundation that would lead to desiccation of salmonid eggs. Therefore, some of the areas surveyed may not have been suitable salmonid spawning habitats on that basis alone.

It is noted that Arctic charr shows a degree of plasticity in their selection of suitable spawning habitats. However, despite there being the potential for Arctic charr spawning, without evidence of the fish populations present, it is based on conjecture. Furthermore, because of steep shelving on both waterbodies, the potentially suitable habitat for Arctic charr to exploit would be limited.

To elucidate the potential impacts on Arctic charr spawning habitat in both working areas, it would be recommended that the presence of the species is indeed confirmed. As such, the EcIA would need to be progressed on a precautionary basis and on an assumption that Arctic charr are present. A method such as gill netting would be best placed to verify this; but would require the operator to control the water level for the duration of the survey. This is a much more invasive survey technique, which may not be proportionate when measures for avoidance and mitigation can be appropriately devised without it. However, the project as a whole does represent a unique opportunity for investigating and furthering our understanding of the species, and a series of surveys could be utilised pre-, during-, and post-construction as part of this.

Macrophytes surveys were limited on both waterbodies due to the topography and safety associated with this. It would be a recommendation that approaching the survey with a modified method using a boat and bathyscope or spyball camera, may allow a wider area to be covered.

6 Riverine Fish Habitat Survey – Inflowing Burns to Cruachan Reservoir

6.1 Methodology

Fish Habitat surveys comprised of a walkover fish habitat assessment on the banks of the inflowing burns; this was undertaken by an SFCC qualified surveyor (Figure 8). Fish habitat surveying is a standardised method of recording physical habitat and follows a modified version of that set out in the SFCC Fish Habitat Survey Handbook (SFCC, 2007).

The primary focus of the survey was to identify whether any salmonid fish spawning habitat would be impacted by the change in water level regime proposed as part of the Proposed Development. Brown trout spawning is typically focused on inflowing burns, whereas Arctic charr may, in addition to the burns, utilise the littoral zone, i.e., narrow strips of coarse substrate (8cm in diameter) running parallel to the shore at a maximum depth of 1.5m.

Where spawning habitat potential was identified, these were subject to further fish population surveys, i.e., electrofishing of the burns and use of either a bathyscope (<1m) or spyball camera at depths (>1m).

A total of eight walkover fish habitat surveys were conducted across Cruachan Reservoir. These investigated inflowing burns to the reservoir and determined their suitability to support fish populations. Additionally, the surveys looked to ascertain whether any salmonid fish spawning habitat within the littoral zones would be impacted because of the change in the water level regime proposed by the project.

6.2 Results

Table 7 below details the suitability of instream habitat, littoral zone habitat, and overall spawning habitat potential.

Across the eight sites, the instream spawning habitat was recorded as either limited spawning gravels or no spawning gravels. The limiting factor in the instream habitat was the lack of gravel within the substrate composition at each site. Results from the littoral zone also highlighted a distinct lack of available spawning gravels, with all eight sites confirming no suitable spawning gravel was available. The limiting factor in the littoral zone was the lack of gravel. Consequently, all eight sites were documented as being an unsuitable habitat for spawning.

Table 7: Fish Habitat Survey – Inflowing Burns to Cruachan Reservoir

Site	Location	Instream Habitat	Littoral Zone Habitat	Spawning Habitat Potential
Cruachan Reservoir Survey Site 1	*NN 07909 28786*	*Substrate: cobble (60%) / pebble (30%) / boulder (5%) / gravel (5%). Limited spawning gravels. Flow type: run (50%) / riffle (50%). Depth <30cm (80% 11-20), width <150m*	*Substrate: cobble and boulders. No suitable spawning gravels. Depth 40-50cm*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 2	*NN 08026 28981*	*Substrate: cobble (60%) / pebble (30%) / boulder (5%) / gravel (5%). Limited spawning gravels. Flow type: run (50%) / riffle (50%). Depth <30cm (80% 11-20), width <150m*	*Substrate: boulders. No suitable spawning gravels. Depth 50cm*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 3	*NN 08039 29002*	*Substrate: cobble (35%) / pebble (30%) / boulder (30%) / gravel (5%). Limited spawning gravels. Flow type: run (40%) / riffle (40%) / torrent (20%). Depth 11-30cm, width <150m*	*Substrate: cobble and boulders. No suitable spawning gravels. Depth >40cm*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 4	*NN 08046 29025*	*Substrate: cobble (50%) / boulder (50%). Limited spawning gravels. Flow type: run (40%) / riffle (40%) / torrent*	*Substrate: cobble and boulders. No suitable spawning gravels. Depth 40-50cm*	*Unsuitable Habitat in both instream and littoral zone habitats*

Site	Location	Instream Habitat	Littoral Zone Habitat	Spawning Habitat Potential
		(20%). Depth 21-30cm, width <150m		
Cruachan Reservoir Survey Site 5	*NN 08430 28781*	*Substrate: cobble (50%) / boulder (50%). Limited spawning gravels. Flow type: run (35%) / riffle (45%) / torrent (20%). Depth 21-30cm, width <150m*	*Substrate: cobble and boulders. No suitable spawning gravels. Depth >50cm*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 6	*NN 08450 29135*	*Substrate: Bedrock and boulders. No spawning gravels. Flow type: shallow glide / run / riffle. Depth 50-100cm*	*Substrate: Bedrock and large boulders. No suitable spawning gravels. Depth >1m*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 7	*NN 08489 29017*	*Substrate: pebble / cobble. No spawning gravels. Flow type: shallow glide / run / riffle. Depth <30cm, width <50cm*	*Substrate: Large boulders. No suitable spawning gravels. Depth >1m*	*Unsuitable Habitat in both instream and littoral zone habitats*
Cruachan Reservoir Survey Site 8	*NN 08437 28795*	*Substrate: pebble / cobble. Limited spawning gravels. Flow type: run / riffle. Depth <20cm, width <50cm*	*Substrate: Cobble and large boulders. No suitable spawning gravels. Depth >1m shelving to >2m*	*Unsuitable Habitat in both instream and littoral zone habitats*

6.3 Discussion

No suitable salmonid spawning habitat was recorded across the eight surveyed inflowing burns and littoral zones to Cruchan Reservoir. The main reason for this was the lack of available spawning substrate type. As discussed previously, spawning substrate type is extremely important in terms of the ability to cut redds, create suitable oxygen levels within the redd, and the ability for waste materials to vacate the redd. It has been documented in previous studies that ideal spawning habitat for salmonids contains 40–80% gravel; 10–40% cobble; <20% boulder; <20% combined silt and sand (Armstrong *et al.*, 2003).

Furthermore, as water levels on the Cruchan Reservoir fluctuate, any small pockets of potential gravels found between larger substrate within the littoral zone, would be unusable as the redds would be exposed and would be threatened with desiccation.

6.4 Conclusions and Recommendations

The habitat walkover surveys conducted on Cruachan Reservoir revealed unsuitable salmonid spawning habitat in the surveyed burns and accompanying littoral zones. Again, because of changeable water levels on the reservoir, any small pockets of potential spawning habitat within the littoral zones would be unusable by fish.

In addition, the gradient of the surrounding landscape in the reservoir makes the inflowing burns unlikely to support fish spawning habitat.

In order to establish if any salmonid fish populations are spawning within the littoral zone of the reservoir, it would first need to be established that they are present. As such, it would be appropriate to use fyke netting on the littoral zones to inform decision making. The only issue being the varying water levels on the reservoir. The inflowing burns did not present any suitable spawning habitat. Consequently, they were not subjected to electro-fishing surveys. However, this should not be ruled out and could give more information on fish populations.

7 Limitations

The use of destructive sampling for fish populations was discounted based on scoping information from NatureScot. It is also good practice to use as few invasive methods as possible when species of conservation interest may be present. Consequently, the approach to fish sampling work was restricted to electric fishing of marginal habitats where suitable around the margins of Cruachan Reservoir and Loch Awe itself adjacent to the existing power station and in the red line planning boundary.

As a result of deep (>15m) shelf, within 5m of the shoreline, macrophyte surveys, shoreline habitat surveys, aquatic invertebrates, and electrofishing for fish population surveys were limited to marginal areas within Loch Awe and Cruachan Reservoir (Figures 12 and 13)

Furthermore, controlled water levels fluctuated daily within Cruachan Reservoir, this meant that areas that had been previously surveyed for macrophytes, fish habitat, fish populations, and aquatic invertebrates were not suitable for any of the species being surveyed (Figure 14). Moreover, it was discussed and concluded with Drax, that the water level could not be kept consistent for the purpose of the survey work. This was discussed with Roddy Davies on site.

Additionally, six of the inflowing burns leading into Cruachan Reservoir had unsuitable habitat or safe access to allow the aquatic invertebrate kick surveys to be conducted (Figure 15).

The red line boundary was amended on 03 May 2022 after completion of aquatic surveys. The new boundary included more terrestrial habitat but didn't alter the survey area for the aquatic habitat. As a result, the assessment in this report for aquatic habitats and species remains accurate.

References

Adams, C.E., Fraser, D., Huntingford, F.A., Greer, R.B., Askew, C.M. & Walker, A.F. (1998) *Trophic polymorphism amongst Arctic charr from Loch Rannoch, Scotland*. Journal of Fish Biology 52. p1259–1271

Armstrong, J. D., Kemp, P. S., Kennedy, G. J. A., Ladle, M. & Milner, N. J. (2003) *Habitat requirements of Atlantic salmon and brown trout in rivers and streams*. Fisheries Research, 62, p.143-170

Bevacqua, D., Melia, P., Gatto, M. & De Leo, G. A. (2015) *A global viability assessment of the European eel*. Global Change Biology, 21, p.3323-3335

Chadd, R. (2010) *Assessment of Aquatic Invertebrates*. Conservation Monitoring in Freshwater Habitats: A Practical Guide and Case Studies. p.63-72

Chapman, D. W. (1988) Critical review of variables used to define effects of fines in redds of large salmonids. Transactions of the American Fisheries Society, 117, p.1-21

Coyle, S., and Adams, C.E. (2011) Development of a methodology for the assessment of the quality of vendace spawning substrate and its application to sites in Scotland and northern England. Scottish Natural Heritage Commissioned Report No. 308

Crisp, D. T. (1996) Environmental requirements of common riverine European salmonid fish species in fresh water with particular reference to physical and chemical aspects. Hydrobiologia, 323, p.201-221

Crisp, D. T. (2000) Trout and salmon: Ecology, conservation, and rehabilitation (Oxford: Fishing News Books)

De Meyer, J., Ide, C., Belpaire, C., Goemans, G. & Adriaens, D. (2015) *Head shape dimorphism in European glass eels* (Anguilla anguilla). Zoology, 118, p.413-423

Dekker, W. (2016) *Management of the eel is slipping through our hands!* Distribute control and orchestrate national protection. Ices Journal of Marine Science, 73, p.2442-2452

Edington, J.M. & Hildrew, A.G. (1995) Caseless Caddis Larvae of the British Isles FBA Publication 53

Elliot, J. M. (1969) Life History and Biology of Sericostoma personatum Spence (Trichoptera). Oikos, 20, p.110-118

Encyclopedia of Life. Retrieved November 11, 2021, from European brook lamprey articles - Encyclopedia of Life (eol.org)

Engblom, E. 1996, Ephemeroptera, Mayflies – In Anders Nilsson (ed.) The Aquatic Insects of Northern Europe: 13-53.

Friday L.E. (1988) A Key to the Adults of British Water Beetles Field Study Council 7: 1-151

Hynes, H.B.N (1993) A Key to Adults and Nymphs of the British Stonefly (Plecoptera) FBA Publication 17

Jacoby, D. M. P., Casselman, J. M., Crook, V., Delucia, M.-B., Ahn, H., Kaifu, K., Kurwie, T., Sasal, P., Silfvergrip, A. M. C., Smith, K. G., Uchida, K., Walker, A. M. & Gollock, M. J. (2015) *Synergistic patterns of threat and the challenges facing global anguillid eel conservation*. Global Ecology and Conservation, 4, p.321-333

Johnson, L. (1980) *The Arctic charr, Salvelinus alpinus*. In: Balon E.K., ed. Charrs: salmonid fishes of the genus Salvelinus. The Hague: Dr W. Junk, p. 15–98

Joint Nature Conservation Committee (JNCC) (2012) (UK Post-2010 Biodiversity Framework (2012–2019). Retrieved October 29, 2021, from https://data.jncc.gov.uk/data/587024ff-864f-4d1d-a669-f38cb448abdc/UK-Post2010-Biodiversity-Framework-2012.pdf

Joint Nature Conservation Committee (JNCC) (2015) Common Standards Monitoring Guidance for Freshwater Lakes. Peterborough: JNCC. p.1-49

Kondolf, G. M., and Wolman, M.G. (1993) *The Sizes of Salmonid Spawning Gravels*. 29. Water Resources Research. p.2275-2286

Louhi, P., Maki-Petays, A. & Erkinaro, J. (2008) *Spawning habitat of atlantic salmon and brown trout: General criteria and intragravel factors*. River Research and Applications, 24, p.330-339

Maitland, P. S. (1990) *Threats to Britains Native Salmon, Trout and Charr*. British Wildlife 5: p.249-261

Maitland, P. S., Winfield, I. J., McCarthy, I. D. and Igoe, F. (2007) *The status of Arctic charr Salvelinus alpinus in Britain and Ireland*. Ecology of Freshwater Fish 16: p6-19

Meiander, M. Megaloptera 1996, – In Anders Nilsson (ed.) The Aquatic Insects of Northern Europe: 105.

Molineri, C., Tejerina, E. G., Torrejón, S. E., Edgardo, J.I. P. & Hankel, Guillermo. (2020) *Indicative value of different taxonomic levels of Chironomidae for assessing the water quality.* Ecological Indicators. Volume 108.

Nilsson, A.N. Coleoptera, 1996, – In Anders Nilsson (ed.) The Aquatic Insects of Northern Europe: 145.

Ottaway, E. M., Carling, P. A., Clarke, A. & Reader, N. A. (1981) *Observations on the structure of brown trout, Salmo-trutta Linnaeus, redds*. Journal of Fish Biology, 19, 593-607

Pinder, L. C. V. (1986) Biology of freshwater Chironomidae. Annual Review of Entomology 31:1 – 23

Raunio, J., Paavola, R., & Muotka, T. (2007) Effects of emergence phenology, taxa tolerances and taxonomic resolution on the use of the Chironomid Pupal Exuvial Technique in river biomonitoring. Freshwater Biology, 52, p.165-176

Reusch, H, & Oosterbroek, P. Diptera Limoniidae & Pedicidae Short Palped Crane Flies – In Anders Nilsson (ed.) The Aquatic Insects of Northern Europe 2: 105.

Scottish Power. (2010) Cruachan Power Station: Biodiversity Information. Retrieved November 11, 2021, from https://www.iberdrola.com/wcorp/gc/prod/es_ES/sostenibilidad/docs/central_cruachan.pdf.

Solem, J.O. & Gullefors, B. Trichoptera 1996, Ephemeroptera, Mayflies – In Anders Nilsson (ed.) The Aquatic Insects of Northern Europe: 223.

Stein, F., Doering-Arjes, P., Fladung, E., Braemick, U., Bendall, B. & Schroeder, B. (2016) Downstream Migration of the European Eel (Anguilla Anguilla) in the Elbe River, Germany: Movement Patterns and the Potential Impact of Environmental Factors. River Research and Applications, 32, p.666-676

The Scottish Fisheries Co-ordination Centre (SFCC). (2007) Training Manual, Habitat Surveys. Inverness: SFCC. p.1-64

The Scottish Fisheries Co-ordination Centre (SFCC). (2014) Training Manual, Fisheries Management Level 3: Team Leader Electrofishing Operations. Inverness: SFCC. p.1-54

Van Der Meer, M. (2012) *Eels over the dykes*: Trap and transport of silver eels in the Netherlands. DUPAN/SEG.

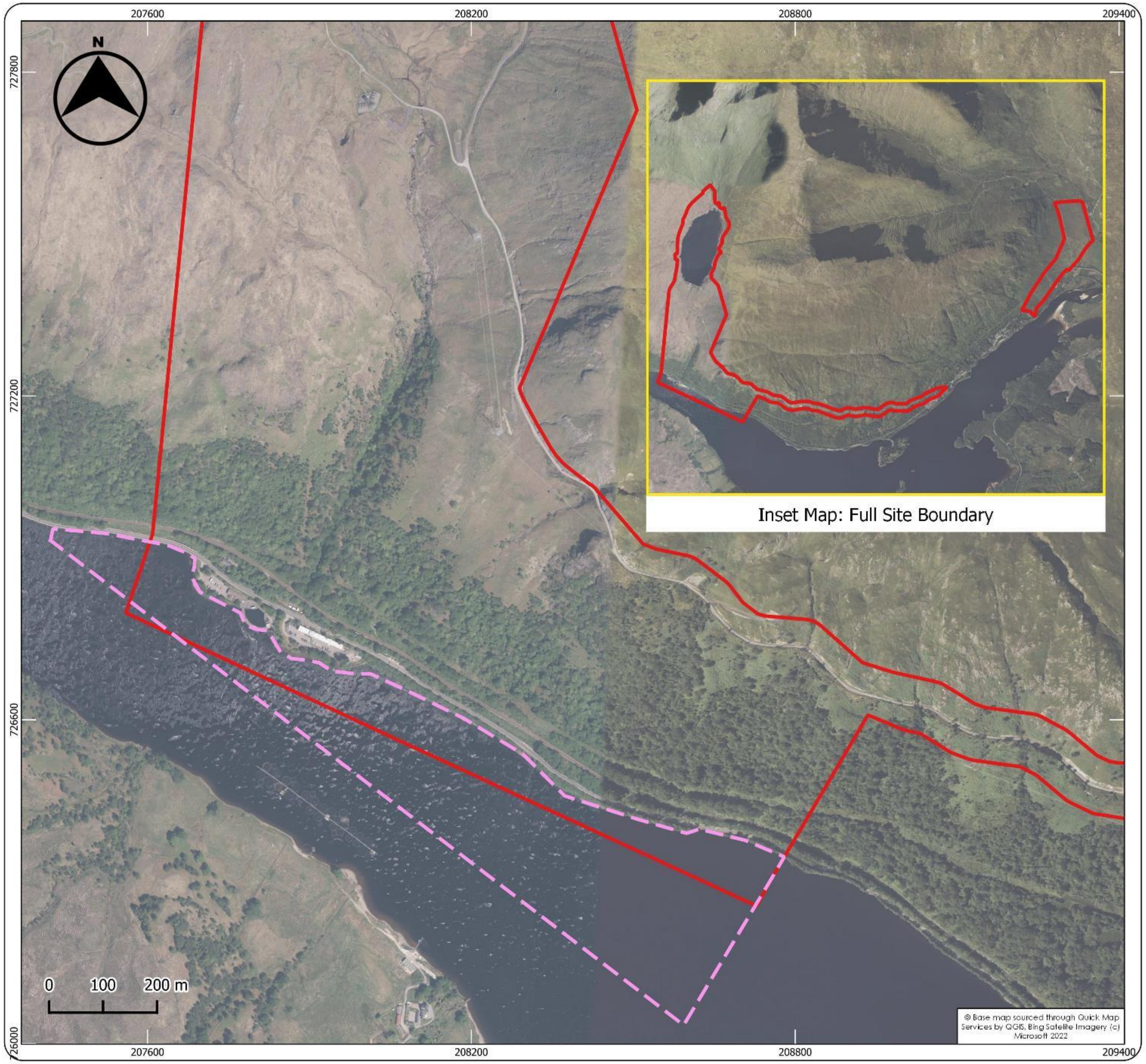
Verhelst, P., Reubens, J., Pauwels, I., Buysse, D., Aelterman, B., Van Hoey, S., Goethals, P., Moens, T., Coeck, J. & Mouton, A. (2018) *Movement behaviour of large female yellow European eel (Anguilla anguilla L.) in a freshwater polder area*. Ecology of Freshwater Fish, 27, p.471-480

Walker, A. (2006). *Stream spawning of Arctic charr in Scotland*. Ecology of Freshwater Fish. 16. p.47 – 53

Wallace, I.D.; Wallace, B. and Philipson, G.N. (2003) FBA Publication 61 Key to Case-Bearing Caddis Larvae of Britain and Ireland

Appendix A Site Maps

Figures presented on subsequent pages.



Legend

Site Boundary

Loch Awe Survey Boundary

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 1: Loch Awe Boundary

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

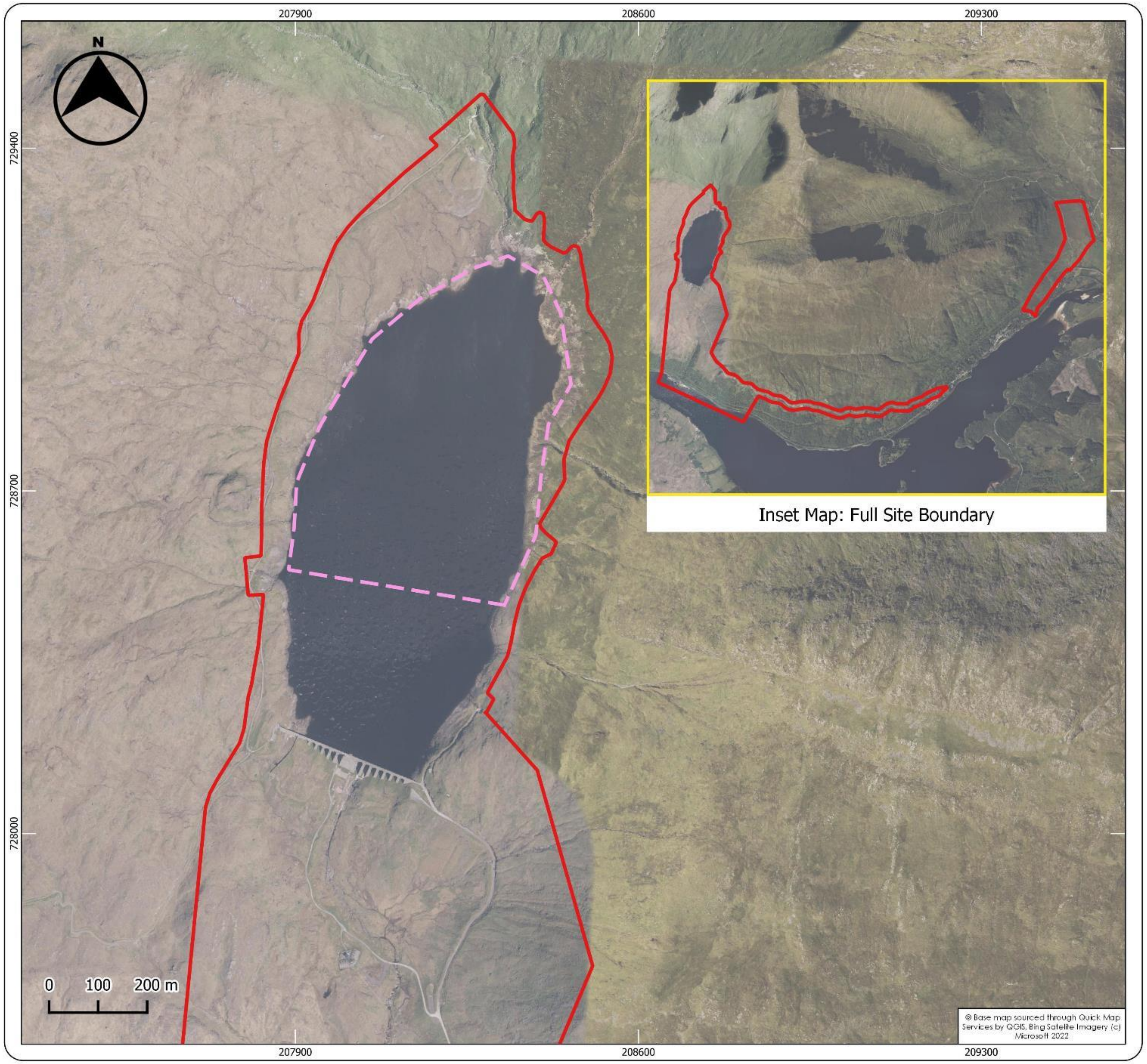
GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685

Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699

Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692

www.gavia-environmental.co.uk



Legend

- Site Boundary
- Cruachan Reservoir Surevy Boundary

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

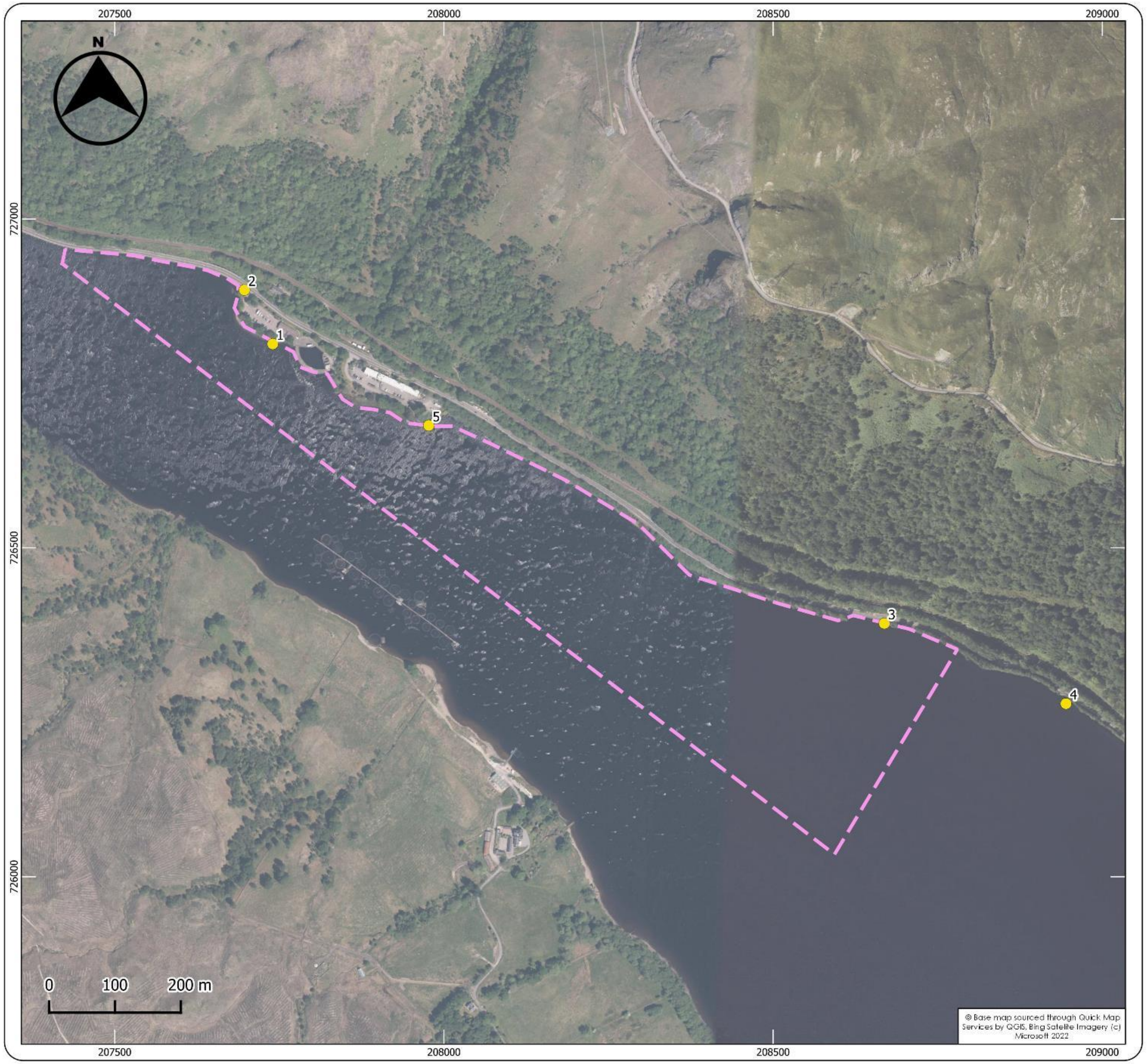
Client:
Applied Ecology Ltd.

Figure Title:
Figure 2: Cruachan Reservoir Boundary

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk



Legend

- Loch Awe Survey Boundary
- Invertebrate Sweep Sample Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

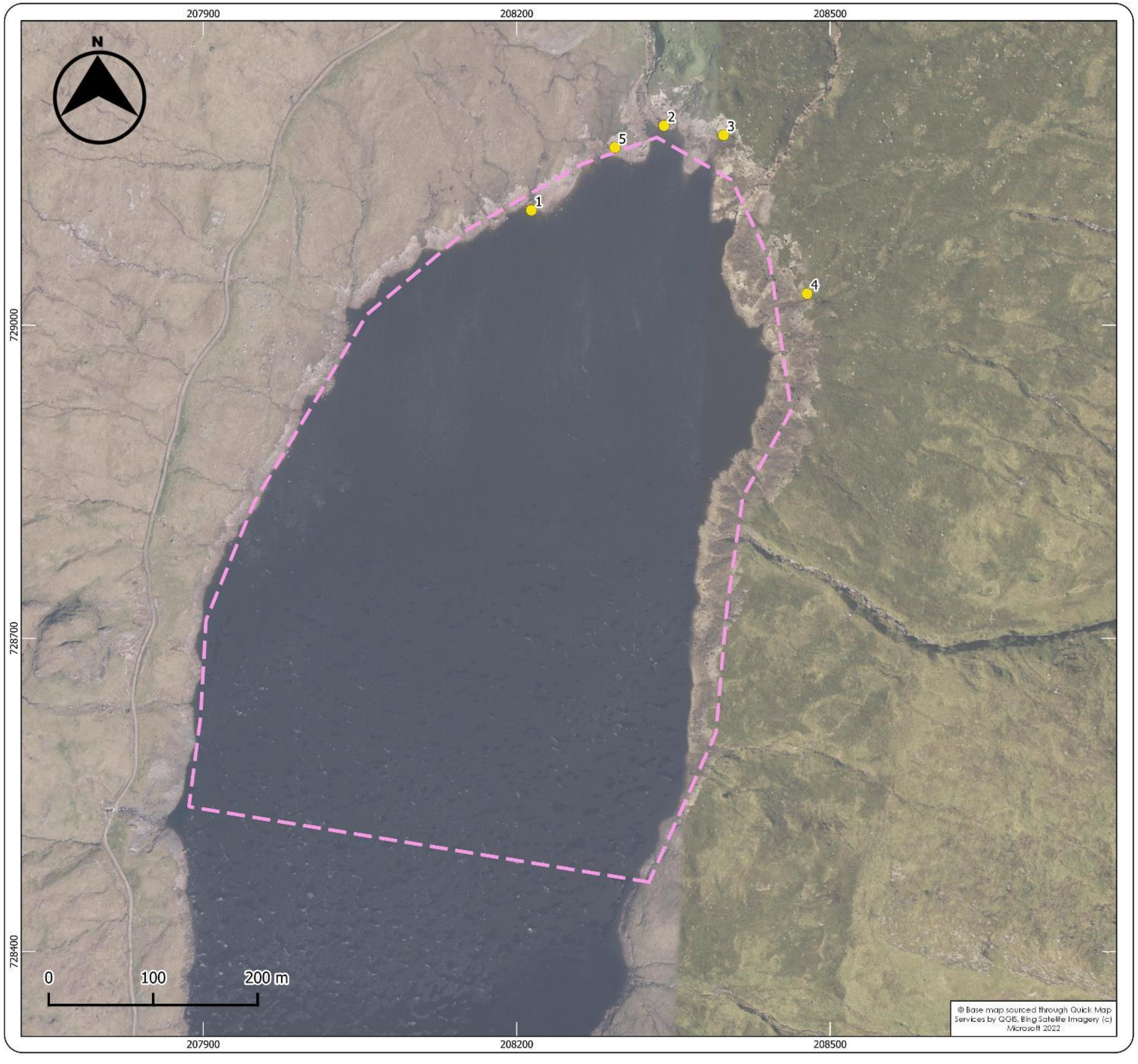
Client:
Applied Ecology Ltd.

Figure Title:
Figure 3: Loch Awe - Aquatic Invertebrates Sweep Samples

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

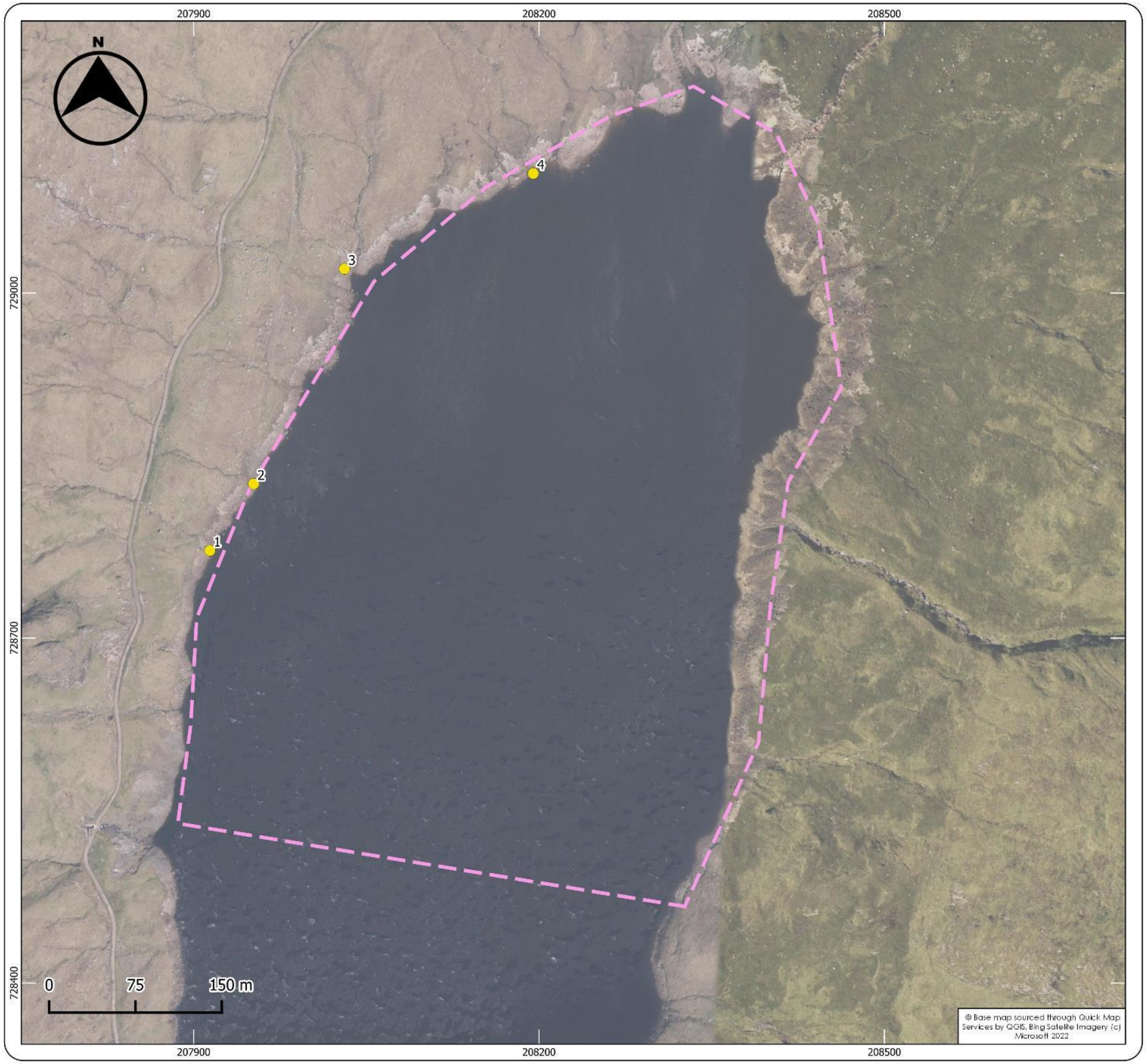
Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk



Legend
Cruachan Reservoir Survey Boundary
Invertebrate Sweep Sample Sites

Project Number: P21273		
Project Title: Cruachan 2 Freshwater Surveys		
Client: Applied Ecology Ltd.		
Figure Title: Figure 4: Cruachan Reservoir - Aquatic Invertebrates Sweep Samples		
Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental
Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk



Legend

- Cruachan Reservoir Survey Boundary
- Cruachan Reservoir Invertebrate Kick Sample Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 5: Cruachan Reservoir - Aquatic Invertebrates Kick Samples

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

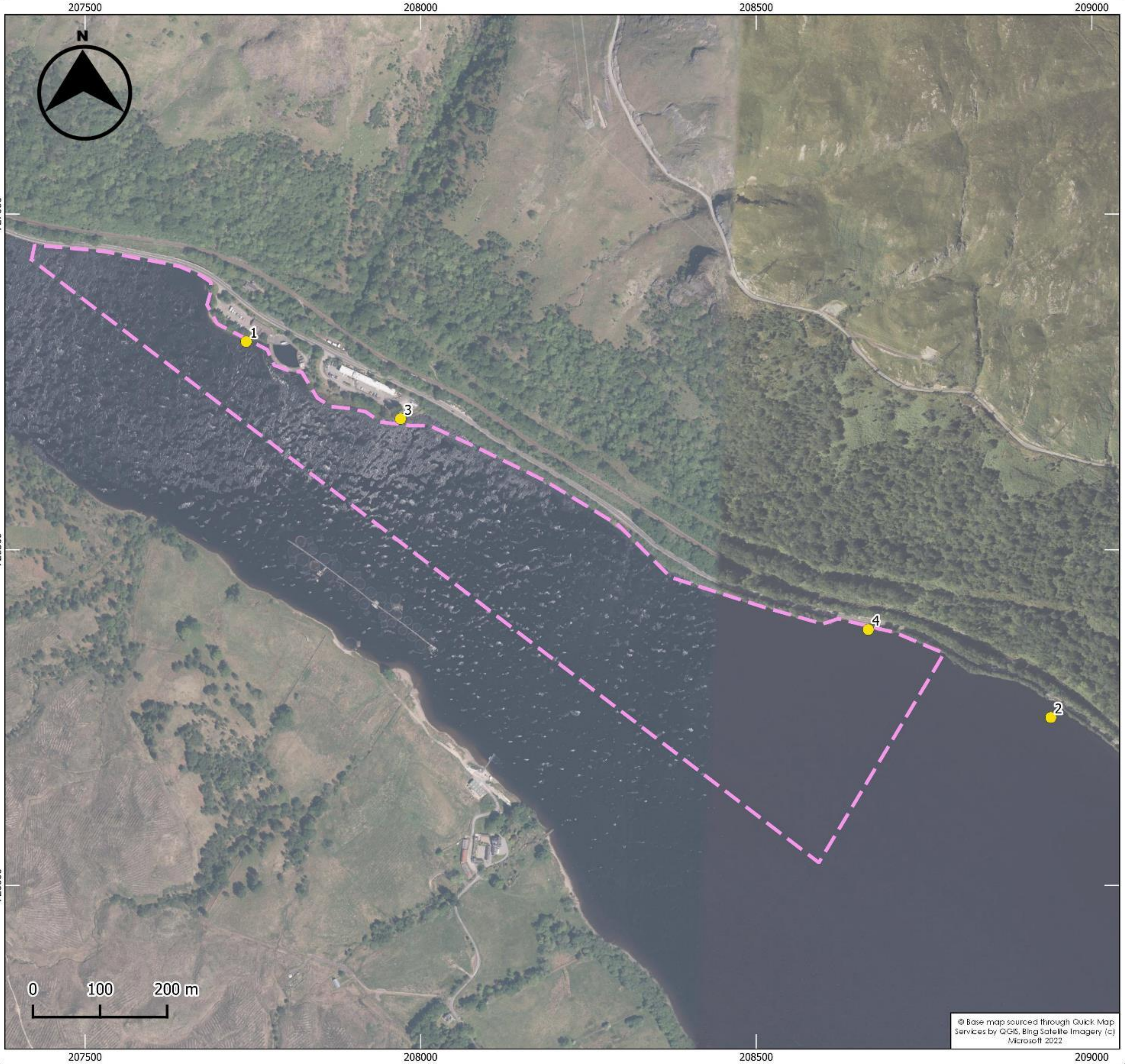
GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685

Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699

Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692

www.gavia-environmental.co.uk



Legend

Loch Awe Survey Boundary

Timed Fish Population Survey Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 6: Loch Awe - Timed Fish Population Survey

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

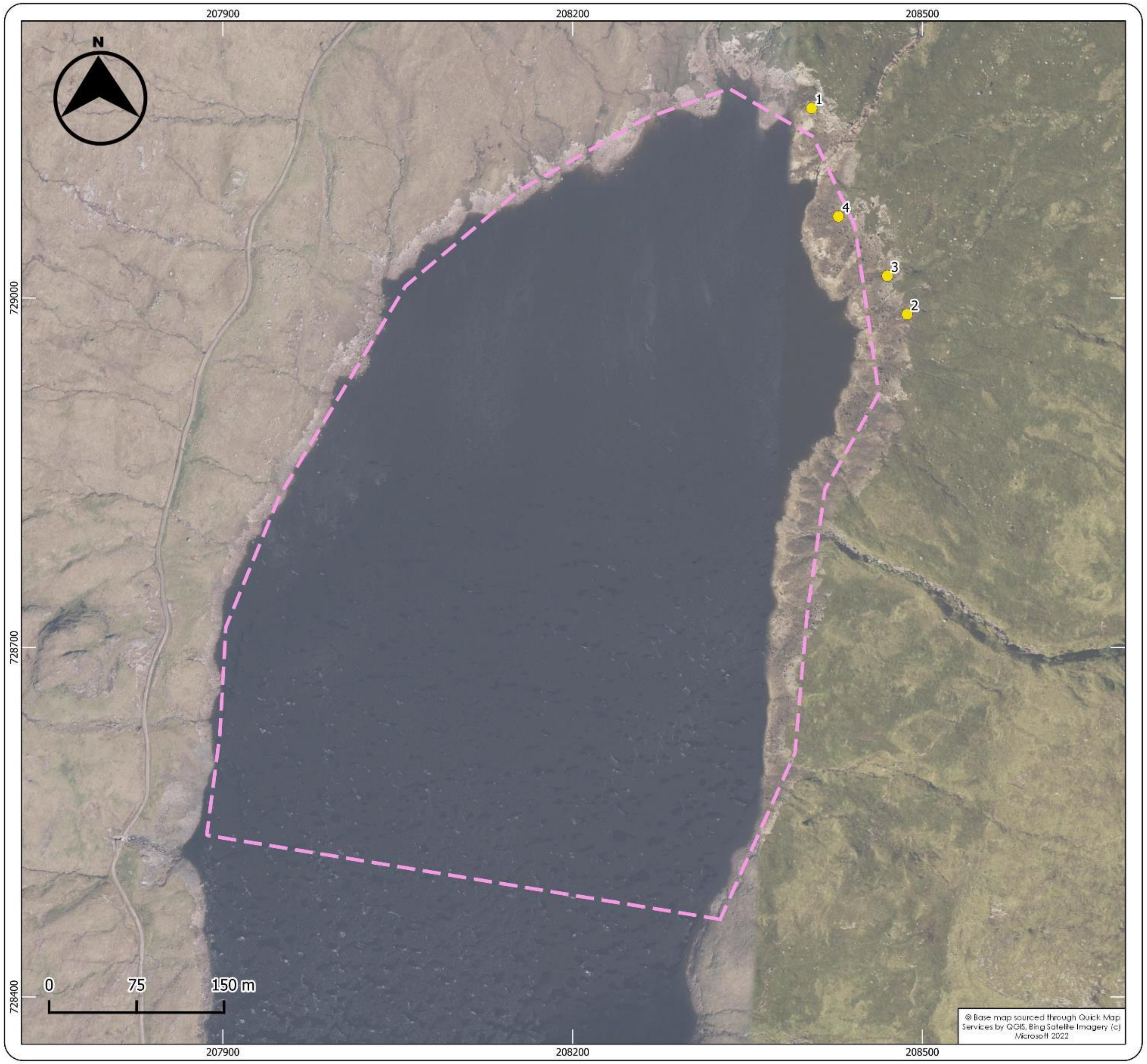
GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685

Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699

Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692

www.gavia-environmental.co.uk



Legend

- Cruachan Reservoir Survey Bondary
- Timed Fish Population Survey Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 7: Cruachan Reservoir - Timed Fish Population Survey

Status: Final	Revision: I	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk

Legend

- Cruachan Reservoir Survey Bondary
- Fish Habitat Walkover Survey Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 8: Cruachan Reservoir - Fish Habitat Walkover Survey

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk

Legend

- Loch Awe Survey Boundary
- Macrophyte Survey Sites

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 9: Loch Awe - Macrophyte Survey

Status: Final	Revision: 1	Page Size: A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685
Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699
Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692
www.gavia-environmental.co.uk

Legend

Loch Awe Survey Boundary

Transects (Bearing 210°)

Transect start locations

id	x	y
1	207493	726947
2	207656	726915
3	207760	726803
4	207879	726711
5	208036	726673
6	208174	726607
7	208302	726528
8	208424	726441
9	208576	726395
10	208730	726366

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 10: Loch Awe - Freshwater Survey Transects

Status:	Revision:	Page Size:
Final	I	A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

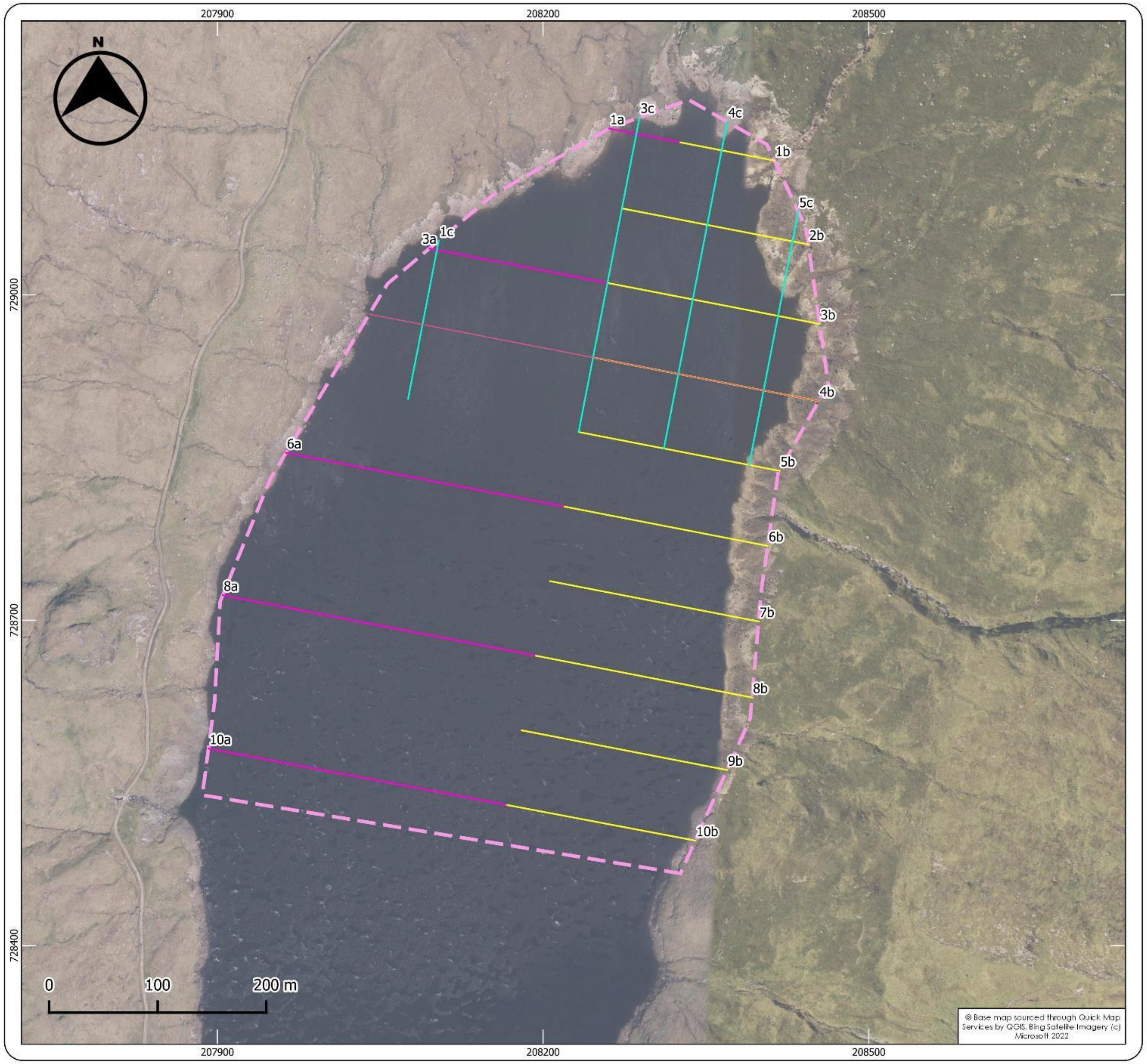
GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685

Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699

Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692

www.gavia-environmental.co.uk



Legend

Cruachan Reservoir Survey Boundary

Transects & Bearings

- A 100°
- B 280°
- C 190°

Transect Start Locations

Label	X	Y
1a	208260	729153
1b	208413	729123
1c	208103	729049
2b	208444	729064
3a	208095	729042
3b	208454	728973
3c	208288	729163
4b	208453	728902
4c	208369	729159

Label	X	Y
5b	208417	728837
5c	208435	729076
6a	207963	728854
6b	208406	728768
7b	208398	728698
8a	207904	728723
8b	208392	728628
9b	208369	728561
10a	207891	728581
10b	208340	728496

Project Number: P21273

Project Title:
Cruachan 2 Freshwater Surveys

Client:
Applied Ecology Ltd.

Figure Title:
Figure 11: Cruachan Reservoir - Freshwater Survey Transects

Status:	Revision:	Page Size:
Final	1	A3
Drawn: BT	Reviewed: VS	Date: 16/05/2022

GAVIA
environmental

Perth: Inveralmond Business Centre, Auld Bond Road, PH1 3FX | Telephone: 1738 718 685

Glasgow: 54 Cook Street, G5 8JQ | Telephone: 0141 401 0699

Nottingham: 16 Commerce Square, Lace Market, NG1 1HS | Telephone: 0115 695 0692

www.gavia-environmental.co.uk

Appendix B Macrophyte Table

Table 6: Macrophyte Survey Results from Loch Awe Transects

Site	Sector	Location	Transect	Total Vegetation Score	Algal Abundance Score	Macrophyte Species
Loch Awe	*1*	*NN 07760 26800*	*T1 0.25m*	*1*	*0*	*Veronica beccabunga* *Mentha aquatica* *Ranunnculus hedaraceus* *Ranunnculus aquatilis* *Potamogeton polygonifolius*
Loch Awe	*1*	*NN 07760 26800*	*T1 0.5m*	*1*	*0*	*Potamogeton crispus*
Loch Awe	*1*	*NN 07740 268100*	*T2 0.25m*	*1*	*0*	*Carex rostrata* *Potamogeton pusillus* *Veronica beccabunga* *Juncus bulbosus (var. fluitans)* *Thamnobryum alopecurum*
Loch Awe	*1*	*NN 07740 68100*	*T2 0.5m*	*1*	*0*	*Fontinalis antipyretica* *Veronica beccabunga* *Carex rostrata* *Myosotis scorpioides*

Appendix C Site Photos

Figure 15: Unsafe access to inflowing burns on Cruachan Reservoir

Figure 16: Substrate on Cruachan Reservoir showing peat and layer of sand

Figure 17: Marginal Substrate and Depths exceeding 1m on the Cruachan Reservoir

Figure 18: Large Substrate and Reclaimed land on Loch Awe (west)

Figure 19: Large Substrate and Reclaimed land on Loch Awe (east)