FISH HABITAT SURVEY

LOCH PATTACK WEIR

GILKES ENERGY

10/03/2022

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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.

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1 Executive Summary

Gavia Environmental Ltd. ('GEL') was commissioned by Gilkes Energy ('the Client') to undertake Fish Habitat Assessments at Loch Pattack and inflowing burns to provide data requested by the Scottish Environmental Protection Agency (SEPA) in regard to a Controlled Activity Regulation Licence for the Development Planning Reference (21/03668/FUL).

This version of the report presents a revision to our earlier report P22018/R1/V1.1 following feedback from the Scottish Environmental Protection Agency's Fish Ecologist on the 2nd March 2022. The feedback requested further information to be presented to further define the areas (m^2) of optimal and sub-optimal fish habitat, following a meeting with SEPA on the 7th March it was agreed that we would focus on the habitat potential in the two main tributaries identified as holding optimal habitat for brown trout spawning; namely the Allt a' Chaoil-rèidhe and the Allt Cam. It was agreed that given the habitat recorded within the River Pattack that it was "*…unlikely the proposed dam will adversely impact on trout recruitment in this section of the Pattack catchment"*.

This report seeks to address SEPA's comments by providing an estimation of the area (m^2) of spawning habitat potential within the first 5km length of watercourse (from loch upwards) on each of the Allt a' Chaoil-rèidhe and Allt Cam. These estimates provides context for the habitat to be changed from optimal spawning habitat to juvenile habitat. These results are based interpretation of remote sensing data obtained from internet sources and calibrated against the findings of the field surveys.

Having analysed the five inflowing/outflowing rivers of Loch Pattack and their aforementioned instream characteristics, it is deemed that Allt a' Chaoil-rèidhe and Allt Cam show the most suitable spawning and nursery habitat. In each of the above watercourses there is potential for some alteration of spawning to juvenile nursery habitat, primarily as a result of inundation by the impoundment of the loch. However, as the inundation would be limited to a few hundred metres of the watercourses upstream of the confluence with the loch, the scale of the loss would be minimal in contrast to the remaining suitable spawning habitat on each watercourse.

Following the interrogation of mapping data, based on the habitat type available within 5km from the confluence with Loch Pattack, an area of approximately **4% of the optimal spawning** habitat available on the **Allt Cam** and **14%** of the **optimal spawning habitat** available on the **Allt a' Chaoil-rèidhe** following the proposed impoundment by the weir.

Furthermore, the alteration of the watercourse habitats do not result in a direct loss of habitat suitable to support trout and would provide, with enhancement measures, to increase the availability of juvenile trout refugia and offer growth and development of trout as they hatch and move downstream from the spawning gravels upstream. Creation of juvenile habitat is considered to offset the loss of spawning habitat. This is because currently the areas of juvenile habitat is restricted in both rivers due to the channel form and morphology. There is only 327m^2 of habitat that constitutes deeper pools and juvenile habitat within the Allt a' Chaoil-rèidhe and 1365m^2 on the Allt Cam. Additional trout refugia, within each river system, may offer additional protection to juvenile fish following hatching and development. These additional areas of juvenile habitat are likely to support the further development of trout populations given the availability of refugia vs spawning habitat potential on both the Allt a' Chaoil-rèidhe and Allt Cam.

Consequently, this may increase the productivity of brown trout populations on both waterbodies and in the loch, in the longer term, and this may present at worst a neutral impact and has the potential to be a positive impact if enhanced with mitigation and enhancement options.

2 Introduction

Gavia Environmental Ltd. ('GEL') was commissioned by Gilkes Energy ('the Client') to undertake Fish Habitat Assessments at Loch Pattack and inflowing burns to provide data requested by the Scottish Environmental Protection Agency (SEPA) in regard to a Controlled Activity Regulation Licence for the Development Planning Reference (21/03668/FUL).

The principal objectives of this survey are to:

Collect baseline ecological field data concerning fish habitat to provide fish habitat data requested by the SEPA in relation to a Controlled Activity Regulation Licence for the Development Planning Reference (21/03668/FUL).

2.1 Background

The Client proposes to construct a new variable weir and associated infrastructure on the River Pattack, approximately 1.8km upstream, south of the operational River Pattack Hydro-electric Reservoir, circa 1.5km North of Loch Pattack (NN 54423 81203) (Figure 1). The function of the proposed weir is to extend the natural pattern of intermittent high-water levels in the loch and river for generating additional renewable energy, as part of the operational Pattack Hydroelectric Reservoir. The proposal would affect around 1.5km of the River Pattack above the proposed weir as well as Loch Pattack, its shallow margins, and the lower reaches of its inflowing burns.

As part of the Development, work is also intended to realign and raise part of an existing access track on the southern bank of Loch Pattack (the southern access track), to levels above maximum flood/inundation height.

The proposed weir would be situated on land belonging to Ardverikie Estate, and the existing track along the southern side of Loch Pattack proposed for realignment and upgrading (the southern access track) is situated on land belonging to Ben Alder Estate. A borrow pit situated within the forestry works on Ben Alder Estate, approximately 1 km east of the southern shore of Loch Pattack, would also be utilised to obtain material for the upgrading and realignment of the southern access track.

2.2 Consultation with Scottish Environmental Protection Agency

On the 12th of January 2022, staff from Gavia Environmental, members of SEPA, and the Client had a consultation which aimed to discuss the Development. During the meeting, the fish habitat walkover assessments that had been completed were discussed. Aerial photographs were displayed to give a visual representation of the surveyed areas and Paul Fraser from Gavia Environmental reviewed the results that had been generated.

Representatives from SEPA then had time to analyse the results and to ask Gavia and the Client any further questions. It was agreed that redd counting could not be conducted due to high water levels and that it was now too late to conduct this type of survey. In addition, it was requested that a map be produced in the report that would illustrate which rivers and stretches had been surveyed.

Lastly, the Client was asked about the feasibility of a fish pass being constructed on the Development to allow instream migration of fish species in the upper reaches of the River Pattack.

2.3 Loch Pattack

Loch Pattack is a sizeable (67ha) oligotrophic loch located at an altitude of 422.6m and located at grid reference NN 53927 79069. It drains to the north via the River Pattack. There are two major inflows, Allt a' Chaoil-rèidhe to the south and Allt Cam to the north-west, and a series of smaller inflowing streams, notably Caochan a' Càthair to the south-west and Caochan Bàn to the east. The catchment is primarily semi-natural, with extensive areas of blanket bog to the south and north, open hill slopes to the west and a conifer plantation to the north-east.

2.4 Designations

Loch Pattack and 'the southern access track' which are part of the proposed Development, lie within the Ben Alder and Aonach Beag Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). Additionally, the Drumochter Hills which is designated as a Special Protection Area (SPA), Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) is located 3km south-east of 'the southern access track'.

2.5 Historic Fish Population Data

A previous report conducted by Waterside Ecology in 2010 prior to the construction of the proposed hydro dam looked at Fish Habitats and Populations on the River Pattack, Allt Mhainisteir, Allt Liath nam Badan, and An Caochan Cuil. The surveys conducted on the River Pattack started at grid reference NN 253700 789600 and ended at NN 254400 781200. They note that the River Pattack is inaccessible to migratory fish due to natural and man-made barriers.

Brown trout (*Salmo trutta*) were found in all survey sites of the River Pattack, but it was observed that densities of fish was greatly reduced in the upper reaches. It was stated in the report that there is a waterfall below the current dam and that both represent impassable barriers. Beyond the end point of the survey, the report states that there are no further barriers and trout residing in that part of the River Pattack would have free access to Loch Pattack and beyond. It was also documented that beyond the lower reaches of the River Pattack, spawning habitat was scarce.

The report also stated that Brook lamprey (*Lampetra planeri*) were observed on the lower reaches of the River Pattack (NN 566903) just upstream of Loch Laggan but were not found in any of the survey sites in the upper reaches. This was because of impassable barriers below the current dam.

Atlantic salmon (*Salmo salar*) and European Minnow (*Phoxinus phoxinus*) are also mentioned in the report but only in the lower reaches of the River Pattack near Loch Laggan. Salmon Parr were present at sites P1 (NN 55068 89473) and P2 (NN 55646 89778) in the report. This is a distance of 8.66km downstream of the proposed Development. European Minnow were present at sites P2 (NN 55646 89778) an P3 (NN 56203 90209). This is 9.18km downstream of the Development. Once again, impassable barriers were noted as being responsible for these findings.

Barriers to migration were noted on the River Pattack and are summarised in Table 1 below and Figure 2. However, it should be noted that the current report was conducted on the upper reaches of the River Pattack where no barriers are recorded to migration.

Table 1: Barriers noted on the River Pattack from Waterside Ecology Report 2010

Watercourse	NGR	Type	Notes
River Pattack	NN56669027	Waterfall	2m in height. Not vertical. May be impassable for smaller salmonids and lamprey.
River Pattack	NN56599015	Rapids	Steep bedrock/waterfall. May be impassable for smaller salmonids and lampreys.
River Pattack	NN56328960	Waterfall	Low flow obstacle
River Pattack	NN56008927	Waterfall	Left channel at island appears passable. Main channel difficult.

River Pattack	NN55988905	Waterfall	Low flow obstacle
River Pattack	NN55668826	Waterfall	Falls of Pattack. Vertical. Estimate height 15m
River Pattack	NN55688784	Waterfall	Approximately 1.8m in height. May be passable for larger trout only.
River Pattack	NN55498738	Waterfall	Two tier waterfall, total heigh approximately 4m.
River Pattack	NN54818590	Waterfall	One metre high and passable to salmonids in all but lowest flows.
River Pattack	NN54818589	Waterfall	Approximately 1.6m high waterfall. Near vertical.
River Pattack	NN54888586	Waterfall	3.5m vertical waterfall followed immediately by second 1m vertical ledge.
River Pattack	NN54908315	Waterfall	Over 2m in height. Possibly passable for larger trout.
River Pattack	NN54918312	Waterfall	Approximately 3m and near vertical. Likely to be impassable for trout.

3 Methodology

3.1 Fish Habitat Walkover Assessment

During the field surveys a combination approach was adopted and observations were made in the context of methods developed by Hendry and Cragg-Hine (1997), and those developed for river/fish habitat surveying (EA, 2003 and SFCC, 2007). Predominant habitat was recorded within specific stretches, and the habitat was classified using the criteria presented in Table 2. The habitats described are regarded as definable parts of a spectrum of habitats commonly found in watercourses. Where spawning gravels were present and accessible, an assessment of their quality in terms of suitability, compaction and siltation was made.

Table 2: Fish Habitat Classifications

Habitat Type	Classification
Salmon spawning gravel	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt. Substrate size predominantly pebbles and smaller cobbles depending on fish size
Trout spawning gravel	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt. Substrate size varies from gravels, pebbles and smaller cobbles depending on fish size
Salmon fry habitat	Shallow (<0.2 m) and fast flowing water indicative of riffles and runs with a substrate dominated by pebbles and smaller cobbles
Salmon parr habitat	Riffle/run habitat that is generally faster and deeper than fry habitat (0.2 - 0.4 m). Substrate size* from large pebbles/smaller cobbles to boulder
Trout fry habitat	Slow to medium flowing shallow water with a substrate dominated by pebbles and smaller cobbles, often concentrated at stream margins
Trout parr habitat	Variety of substrate sizes; undercut banks, tree roots, big rocks; deeper, slower water

Fish Habitat surveys comprised of a walkover fish habitat assessment on the banks of five of the inflowing burns/outflowing burns of Loch Pattack; this was undertaken by an SFCC qualified surveyor (Figure 3). At each inflowing/outflowing burn a series of SFCC Habitat Survey Sheets were completed to provide information on water depths, flow types, substrate types, fish cover, spawning suitability, and other instream characteristics (Figure 4)

Water depth was divided into six categories (<10, 11-20, 21-30, 31-40, 41-50 and >50 cm). A measuring stick was used to calibrate visual estimates before recording overall percentages of each depth as portions of the total wetted area.

Instream characteristics such as flow types, substrate composition, and fish cover were estimated similarly. Water flow types were estimated across eight categories: (1) SM - Still Marginal, <10cm deep, (2) DP - Deep Pool, >= 30cm deep, (3) SP - Shallow Pool, <30cm deep, on these first three points water flow is still, slow, or eddying, smooth on surface and silent. (4) DG – Deep Glide, >= 30cm deep, (5) SG - Shallow Glide, <30cm deep, on both these points water flow is moderate/fast, smooth on surface and silent. (6) RU - Run, water is fast and silent, (7) RI - Riffle, water fast and audible (8) TO - Torrent, white water and noisy.

Substrate was categorised by particle size as follows: (1) HO - High organic, (2) SI - Silt, (3) SA - Sand, <=2mm diameter, (4) GR - Gravel, 2-16mm diameter, (5) PE - Pebble, 16-64mm diameter, (6) CO - Cobble, 64-256mm diameter, (7) BO - Boulder, >256mm diameter, (8) BE - Bedrock, continuous rock surface and (9) OB – River bed obscured by debris. Instream vegetation was estimated as the percentage of the survey area covered by macrophytes and/or algae capable of providing cover for fish. The presence or absence of large-scale siltation on the surface of the stream bed was recorded as Y/N. The stability (stable or unstable) and the degree of compaction of the stream bed (compacted, partly compacted, or un-compacted) were determined for the survey stretch.

The left and right banks of the stream are always identified in a downstream direction; features of the riparian vegetation were recorded associated with each. Bankside cover was estimated in percentages across seven categories: (1) UC - Undercut, (2) DR - Draped, (3) BA - Bare, (4) MA - Marginal, (5) RT - Roots, (6) RK - Rocks, (7) OTH - Other. Total fish cover was recorded as the percentage of each survey bank length that provided cover for fish.

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 Development. Brown trout spawning is typically focused on inflowing burns, whereas Arctic charr may, in addition to the burns, also utilise the littoral zone, i.e., narrow strips of coarse substrate (8cm) running parallel to the shore at a maximum depth of 1.5m.

3.2 Remote Sensing Habitat Characterisation

Fish habitat potential was interrogated using remote sensing data obtained from Bing Maps (aerial imagery) accessed 08 & 09 March 2022. These data were viewed and areas of gravels, pebbles, cobbles were easily identifiable unsuitable habitat in the form of deeper slower water areas, and areas of exposed side/channel bars. AutoCad was used to calculate those areas of optimal spawning habitat based on the criteria identified in above. Unsuitable habitat was identified as the exposed gravel bars and deep pools.

3.3 Boat Based Fish Habitat Assessment

The habitat survey was conducted by three experienced Ecologists using a combination of perpendicular and latitudinal boat transects on Loch Pattack (Figure 5) The boat-based transects extended until a depth in excess of 10m 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 composition 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 Speedtech Instruments handheld echo sounder.

4 Limitations

Due to the time of year of this commission; only habitat-based survey work was possible. If electric fishing of the river systems is required, this would need to be undertaken in July 2022.

Additionally, as a result of high-water levels, it was impossible to survey for any brown trout redds that may have been present in the inflowing/outflowing burns of Loch Pattack.

Interrogation of the remote sensing data is dependent upon the image available at the time of access. The results of the area calculations have been based on the image accessible between 07 and 10 March 2022.

5 Results

Table 3 below details each of the five rivers surveyed and their spawning suitability for salmonid fish. In addition, figures 6 -10 provide visual reference to the rivers and their spawning suitability.

Table 3: Fish Habitat Walkover Survey Assessment Results

River	Survey Stretch	Location	Instream Habitat	Spawning Habitat Potential
Coachan Bàn	1	NN 54285 79032 NN 54405 78923	Water depth % 41-80cm 70%, >80cm 20%, 0-20cm 10%. Substrate % high organic 70%, sand 15%, silt 10%, gravel 5%. Stable and compacted. Instream vegetation 70%. No Siltation. Flow type % deep glide 60%, deep pool 30%, 10% run. Bankside cover on the left and right banks was 50%. Limiting factors: Water depth, lack of spawning gravel, and unsuitable flow type.	U[redacted]able Spawning Habitat
Coachan Bàn	2	NN 54404 78918 NN 54428 78768	Water depth % 41-80cm 50%, >80cm 20%, 0-20cm 20%, 21-40cm 10%. Substrate % high organic 50% silt 40%, sand 5% and gravel 5%. Instream vegetation 60%. Stable and Compacted. No Siltation. Flow type % deep pool 30%, shallow pool 25%, deep glide 25%, run 15%, riffle 5%. Bankside cover on both banks 15%. Limiting factors: Water depth, lack of spawning gravel, unsuitable flow type.	Unsuitable Spawning Habitat
Allt a' Chaoil-rèidhe	1	NN 53702 78612 NN 53973 78426	Water depth % 21-40cm 50%, >80cm 20%, 41-80cm 20%, 0-20cm 10%. Substrate % pebble 50% and gravel 30%, cobble 10%, sand 10%. Stable and Uncompacted. No Siltation	Optimal Spawning Habitat

			Flow type % deep glide 40%, run 30%, shallow glide 15%, riffle 10%, deep pool 5%. Bankside cover on both banks was found to be 0%.	
Allt a' Chaoil-rèidhe	2	NN 53973 78426 NN 54124 78177	Water depth % 21-40cm 60%, >80cm 10%, 41-80cm 20%, 0-20cm 10%. Substrate % gravel 50%, pebble 30%, cobble 10%, sand 10%. Stable and Uncompacted Instream vegetation 5% no siltation. Flow type % run 60%, riffle 15%, deep glide 15%, shallow glide 5% deep pool 5%. Bankside cover on both banks 0%.	Optimal Spawning Habitat
Coachan Ruadh	1	NN 53267 78450 NN 53289 78274	Water depth % >80cm 50%, 41-80cm 20%, 21-40cm 15%, 0-20cm 15%. Substrate % high organic material 50%, gravel 15%, pebble 15%, sand 10%. Stable and Partly Compacted. Instream Vegetation 50%. No Siltation. Flow type % deep glide 50%, deep pool 20%, run 15%, riffle 10%, shallow pool 5%. Bankside cover on the left bank 30%. Bankside cover on the right bank 30%. Limiting factors: Water depth, and unsuitable flow type. Marginally better substrate.	Sub-Optimal Spawning Habitat
Allt Cam	1	NN 54020 79422 NN 53543 79838	Water depth % 0-20cm with 70%, 21-40cm 20% 41-80cm. Substrate % gravel 25%, pebble 25%, cobble 25%, boulder 20%, sand 5%. Unstable and Uncompacted. oo siltation or instream vegetation. Flow type % run 40%, riffle 40%, shallow glide 10%, deep glide 5%, still marginal 5%. No bankside fish cover.	Optimal Spawning Habitat
River Pattack	1	NN 54423 81203 NN 54301 80981	Water depth % >80cm 65%, 41-80cm 20%, 21-40cm 10%, 0-20cm 5%. Substrate % 50% cobble, 30% boulder, high organic 5%, sand 5%, gravel 5%, and pebble 5%. Stable and Partly Compacted. Instream vegetation 5%. No siltation. Flow type % deep glide 60%, deep pool 35%, still marginal 5%. No bankside fish cover. Limiting factors: Water depth, lack of spawning gravel, unsuitable flow type.	Unsuitable Spawning Habitat

River Pattack	2	NN 54301 80981 NN 54273 80876	Water depth % 21-40cm 60%, 41-80cm 30%, 0-20cm 10%. Substrate % pebble 60%, cobble 20%, gravel 10%, boulder 5%, sand 5%. Stable and Uncompacted. Instream Vegetation 5%. No siltation. Flow type % run 50%, riffle 30%, shallow glide 15%, still marginal 5%. No bankside fish cover. Limiting factors: Lack of spawning gravel but good % of pebbles.	Sub-Optimal Spawning Habitat
River Pattack	3	NN 54273 80876 NN 54270 80757	Water depth % >80cm category 65%, 41-80cm 25%, 21-40cm 5%, 0-20cm 5%. Substrate % sand 35%, cobble 25%, high organic 10%, silt 10%, boulder 10%, gravel 5%, pebble 5%. Stable and Partly Compacted. Instream vegetation 10%. No siltation. Flow type % deep glide 50%, deep pool 25%, run 20%, still marginal 5%. No bankside fish cover. Limiting factors: Water depth, lack of spawning gravel, unsuitable flow type.	Unsuitable Spawning Habitat
River Pattack	4	NN 54270 80357 NN 54152 79788	Water depth % >80cm 60%, 41-80cm 30%, 21-40cm 5%, 0-20cm 5%. Substrate % sand 40%, cobble 20%, high organic 10%, silt 10%, boulder 10%, gravel 5%, pebble 5%. Stable and Partly Compacted. Instream vegetation 10%. No siltation. Flow type % deep pool 40%, deep glide 35%, still marginal 5%, shallow glide 5%, run 5%, riffle 5%. No bankside fish cover. Limiting factors: Water depth, lack of spawning gravel, unsuitable flow type.	Unsuitable Spawning Habitat

5.1 Caochan Bàn

In total, two survey stretches covering 310m were completed on the Coachan Bàn. The first stretch starting at NN 54285 79032 and ended at NN 54405 78923 covered a distance of 160m. Water depth % was primarily in the 41-80cm category at 70%, the remaining depth % was split across >80cm 20% and 0-20cm 10%. Substrate % was mostly high organic 70%, with the remaining % found in the following categories, sand 15%, silt 10%, and gravel 5%. Instream vegetation was observed to be 70% and the survey stretch was not silted. The substrate was noticed to be stable and compacted.

Flow type % was mainly deep glide 60% and deep pool 30%, with 10% of run. Bankside cover on the left and right banks was provided by draped vegetation and were both logged at 50% (Plate 1).

The second survey stretch comprising of 150m had a starting location of NN 54404 78918 and ended at NN 54428 78768. Water depth % was mainly 42-80cm 50%, with >80cm 20%, 0-20cm 20%, and 21-40cm 10%. Substrate % was mostly split between high organic 50% and silt 40%, with smaller percentages of both sand 5% and gravel 5%. Instream vegetation was recorded at 60% and siltation was not documented. Substrate was described as stable and compacted.

Flow type % was spread across deep pool 30%, shallow pool 25%, deep glide 25%, run 15%, and riffle 5%. Bankside cover on both banks was noted as being 15% and was provided by draped vegetation (Plate 2).

Spawning suitability for salmonid fish was recorded as being unsuitable on both survey stretches of Coachan Bàn.

5.2 Allt a' Chaoil-rèidhe

Two survey stretches totalling 620m were achieved on the Allt a' Chaoil-rèidhe; with a total of 5km assessed via remote sensing.

The first of the physical survey stretches covering 330m started at grid reference NN 53702 78612 and ended at NN 53973 78426. Water depth % was highest in the category of 21-40cm 50%, the remaining % was split between >80cm 20%, 41-80cm 20%, and 0-20cm 10%. Substrate composition was largely that of pebble 50% and gravel 30%, with cobble and sand both contributing 10%. Instream vegetation was observed as being low at 10% and the stretch had no siltation. Substrate was recorded as being stable and uncompacted.

Flow type % was highest in both deep glide 40% and run 30% categories, with shallow glide 15%, riffle 10%, and deep pool 5% all contributing to the remaining percentage. Bankside cover on both banks was documented as 0%. Extended notes highlight that 70% of survey stretch would have suitable spawning habitat (Plate 3).

The second physical survey stretch encompassing 290m of Allt a' Chaoil-rèidhe started at NN 53973 78426 and ended at NN 54124 78177. Water depth % was largest in the category of 21-40cm 60%, the remaining % was split between >80cm 10%, 41-80cm 20%, and 0-20cm 10%. Substrate % was predominantly gravel 50% and pebble 30%, with cobble 10%, and sand 10% providing the remaining %. Instream vegetation was noted at 5% and the stretch had no siltation. Substrate was recorded as being stable and uncompacted.

Flow type % was chiefly in the category of run 60%, the remaining percentage included riffle 15%, deep glide 15%, shallow glide 5% and deep pool 5%. Bankside cover on both left and right banks was documented as 0%. Further notes indicate that 60% of survey stretch would have suitable spawning habitat (Plate 4).

Spawning suitability for salmonid fish was recorded as being optimal on both survey stretches of Allt a' Chaoil-rèidhe.

Calibrating the above data against that observed from the remote sensing data it was possible to calibrate habitat types from the aerial imagery obtained from detailed aerial mapping.

Using remote sensing data it was estimated that approximately **14%** of the potential optimal spawning habitat available will be transformed to juvenile refugia.

The above percentage transformation estimate was based on an estimate of the total available **optimal spawning habitat** within the first 5km being calculated at **62,339m^2**. When the area of the inundation zone is applied to the tributary it was calculated that **8,821m^2** of habitat had the potential to be transformed from spawning to juvenile refugia by inundation of the loch over those spawning gravels.

Areas of **juvenile fish refugia** within 5km from the confluence with the Loch Pattack was limited to **1599m^2** with only **327m^2** outwith the area of potential inundation.

5.3 Caochan Ruadh

One survey stretch was undertaken from Ross's bridge covering 180m upstream on the Coachan Ruadh. The stretch started at grid reference NN 53267 78450 and ended at NN 53289 78274. Water depth % was mainly >80cm 50%, with the remaining % spread across 41-80cm 20%, 21-40cm 15%, and 0-20cm 15%. Substrate % was predominantly high organic material 50%, with some gravel 15%, pebble 15%, and sand 10%. The survey stretch was not silted but did contain a large percentage of instream vegetation 50%. Substrate was recorded as being stable and partly compacted.

Flow type % was chiefly deep glide 50% and deep pool 20%, with less run 15%, riffle 10%, and shallow pool 5%. Bankside cover on the left bank was noted as 30% and provided by draped vegetation. Similarly, bankside cover on the right bank was documented as 30% and provided by draped vegetation (Plate 5).

Spawning suitability for salmonid fish was detailed as being sub-optimal.

5.4 Allt Cam

One survey stretch was conducted on the Allt Cam within 630m and a total of 5km was assessed via remote sensing data. The physical survey stretch started at NN 54020 79422 and ended at NN 53543 79838. Water depth % was chiefly in the range between 0-20cm with 70% of the stretch deemed to be in this category, 21-40cm was found to be 20% of the survey stretch, and the remaining 10% was in the category of 41-80cm. Substrate % was evenly split between gravel 25%, pebble 25%, and cobble 25%, with the remaining substrate divided between boulder 20% and sand 5%. Substrate was documented as being unstable and uncompacted. Additionally, no siltation or instream vegetation was observed. It was noted that the substrate would provide good salmonid fry and parr cover, as well as being suitable spawning substrate.

Flow type % were dominated by run 40% and riffle 40% sequences, with the remaining flow types being recorded as shallow glide 10%, deep glide 5%, and still marginal 5%. No bankside fish cover was noted on either bank within the survey stretch (Plate 6 and 7).

Spawning suitability for salmonid fish was described as optimal on Allt Cam.

Using remote sensing data it was estimated that approximately **4%** of the potential optimal spawning habitat available in the Allt Cam within the first 5km upstream from the current loch edge. This was based on an estimate of the total available **optimal spawning habitat** within the first 5km being calculated at **52,789m^2**. It was calculated that **2,089m^2** of habitat potentially transformed from spawning to juvenile refugia by the inundation of the loch over those spawning gravels.

The estimated area of **juvenile habitat for trout is 1365m^2** within 5km of the river from the confluence with the Loch Pattack. No juvenile habitat for trout was located within the inundation zone for the Allt Cam.

5.5 River Pattack

In total, four survey stretches covering 1.06km were completed on the River Pattack. The first survey stretch started at grid reference NN54423 81203 and ended at NN 54301 80981, a distance of 250m. At the start of the survey stretch otter spraint was noted below the Ardverikie Top Bridge. Water depth was largely in the category >80cm 65%, followed by 41-80cm 20%, with 21-40cm 10%, and 0-20cm 5%. Substrate % was found to contain 50% cobble and 30% boulder, the remaining % was evenly distributed between high organic 5%, sand 5%, gravel 5%, and pebble 5%. The substrate was noted as being stable and partly compacted. In addition, 5% of the survey stretch contained instream vegetation but no siltation was recorded. Flow type % was mainly divided between deep glide 60% and deep pool 35%, with some still marginal 5%. No bankside cover was observed throughout the survey stretch (Plate 8).

The second survey stretch recorded on the River Pattack had a starting point of NN 54301 80981 and an end point of NN 54273 80876. This stretch covered a distance of 110m and was noted as having sub optimal spawning habitat. In addition, an otter spraint was discovered at NN 54285 80931. Water depth was mainly in the category of 21-40cm 60%, with 41-80cm 30% and 0-20cm 10%. Substrate type % was largely pebble 60%, with cobble 20%, gravel 10%, boulder 5%, and sand 5%. Substrate was found to be stable and uncompacted. Moreover, the survey stretch contained 5% instream vegetation and no siltation. The dominant flow type was that of run 50% and riffle 30%, with some shallow glide 15% and still marginal 5%. No bankside fish cover was observed throughout the survey stretch (Plate 9).

A third stretch spanning 120m was conducted between NN 54273 80876 and NN 54270 80757. It was recorded that an otter spraint was found at grid reference NN 54315 80400. Water depth was notes as being highest in the >80cm category 65%, with 41-80cm 25%, 21-40cm 5%, and 0-20cm 5%. Substrate % was found to be mainly sand 35% and cobble 25%, with high organic 10%, silt 10%, boulder 10%, gravel 5%, and pebble 5%. Substrate was recorded as being stable and partly compacted. It was also discovered that 10% of the survey stretch had instream vegetation and the stretch was not experiencing siltation. Flow type % was chiefly in the category of deep glide 50%, followed by deep pool 25%, run 20% and still marginal 5%. No bankside fish cover was detected on along the survey stretch (Plate 10).

The final survey stretch on the River Pattack was taking over a distance of 580m, starting at NN 54270 80357 and ending at NN 54152 79788. An otter spraint was viewed at grid reference NN 54238 80177. Water depths were highest in the category >80cm 60%, with 41-80cm 30%, 21-40cm 5%, and 0-20cm 5%. The predominant substrate type was sand 40%, with smaller areas of cobble 20%, high organic 10%, silt 10%, boulder 10%, gravel 5%, and pebble 5%. The substrate was documented as being stable and partly compacted. Additionally, 10% of the survey stretch contained instream vegetation and the stretch did not suffer from any siltation. Flow type was mostly split between deep pool 40% and deep glide 35%, with some still marginal 5%, shallow glide 5%, run 5%, and riffle 5%. Bankside fish cover on both the left and right banks was recorded as 0% (Plate 11).

Overall, the River Pattack survey stretches deemed the river unsuitable for salmonid spawning. However, survey stretch 2 did offer some sub-optimal spawning habitat.

5.6 Loch Pattack

Boat based fish Habitat surveys were conducted across Loch Pattack. In total 9 transects and 34 sampling points were undertaken. The results from the survey indicate that substrate composition for potential salmonid spawning habitat was unsuitable. This is due to either the substrate type not containing enough spawning substrate or the high percentage of 'fines' such as sand and mud (Table 4).

Table 4: Fish Habitat Survey – Loch Pattack

Transect	Target Note	Depth (m)	Substrate Type %									Spawning Habitat Potential
			BE	BO	CO	PE	GR	SA	SI	CL	MU	
1	LP1A	0.5M	0	0	50	25	0	25	0	0	0	Unsuitable
	LP1B	1.2m	0	0	0	10	15	75	0	0	0	Unsuitable
	LP1C	1.4m	0	0	0	0	0	80	0	0	20	Unsuitable
	LP1D	1.4m	0	0	0	0	0	80	0	0	20	Unsuitable

	LP1E	1.2m	0	0	0	0	0	80	0	0	20	Unsuitable
2	LP2A	0.4m	0	0	0	0	50	50	10	0	0	Unsuitable
	LP2B	0.4m	0	0	0	25	25	50	0	0	0	Unsuitable
	LP2C	0.7m	0	0	0	5	10	85	0	0	0	Unsuitable
	LP2D	1.3M	0	0	10	0	0	45	0	0	45	Unsuitable
3	LP3A	0.4m	0	0	0	0	50	50	0	0	0	Unsuitable
	LP3B	0.5m	0	0	0	10	10	80	0	0	0	Unsuitable
	LP3C	1.5m	0	0	0	0	0	70	0	0	30	Unsuitable
	LP3D	2.6m	0	0	0	0	0	60	0	0	40	Unsuitable
4	LP4A	0.1m	0	0	0	5	0	95	0	0	0	Unsuitable
	LP4B	0.4M	0	0	0	5	10	85	20	0	0	Unsuitable
	LP4C	0.6M	0	0	0	10	5	85	0	0	0	Unsuitable
	LP4D	1.4m	0	0	0	0	0	50	0	0	50	Unsuitable
5	LP5A	0.5M	0	0	0	0	0	100	0	0	0	Unsuitable
	LP5B	0.7m	0	0	0	0	0	100	0	0	0	Unsuitable
	LP5C	2.4m	0	0	0	0	0	70	0	0	30	Unsuitable
6	LP6A	0.4m	0	0	0	30	20	50	0	0	0	Unsuitable
	LP6B	3.4m	0	0	0	0	0	80	0	0	20	Unsuitable
	LP6C	3.9m	0	0	0	0	0	50	0	0	50	Unsuitable
7	LP7A	0.4m	0	0	0	0	0	100	0	0	0	Unsuitable
	LP7B	0.7m	0	0	0	0	0	100	0	0	0	Unsuitable
	LP7C	1.3m	0	0	0	0	0	80	0	0	20	Unsuitable
	LP7D	1.5m	0	0	0	0	0	70	0	0	30	Unsuitable
8	LP8A	0.9m	0	0	0	0	0	10	0	0	90	Unsuitable
	LP8B	2.3m	0	0	0	0	0	0	0	0	100	Unsuitable
	LP8C	2.7m	0	0	0	0	0	50	0	0	50	Unsuitable
9	LP9A	0.6m	0	0	0	50	20	30	0	0	0	Unsuitable
	LP9B	1.3m	0	0	0	0	0	80	0	0	20	Sub-Optimal
	LP9C	1.7m	0	0	0	0	0	80	0	0	20	Unsuitable
	LP9D	3.2m	0	0	0	0	0	50	0	0	50	Unsuitable

Table 5: Observed vs Impacted Spawning Habitat

Tributary	Estimated Trout Spawning Habitat within the Inundation Zone	Estimated Juvenile Trout Refugia within the Inundation Zone	Estimated Trout Spawning Habitat Outwith the Inundation Zone	Estimated Juvenile Trout Refugia Outwith the Inundation Zone
Allt a' Chaoil-rèidhe	8,821m^2	1,272m2	62,339m^2	327m2
Allt Cam	2,089m^2	0m^2	52,789m2	1,365m^2

6 Discussion

6.1 Brown Trout Spawning and Spawning Habitat Requirements

Independent of river size, the distribution of salmonid spawning sites are firmly influenced by numerous instream characteristics (Louhi *et al.*, 2008) Therefore, critical characteristics of suitable spawning grounds may vary between different river systems and geographical areas. Water depth, velocity, and substrate size, however, are generally considered the most significant instream microhabitat variables in determining the spawning habitat selection of salmonid fish (Armstrong *et al.*, 2003).

The general life cycle of brown trout (*Salmo trutta*) follows a pattern which is common to other Salmonids and members of the genus *Salmo*. Brown trout usually spawn in running water in autumn/winter on gravelly/stony beds (Klemetsen *et al.*, 2003). Female trout excavate nests (or "redds") in this preferred area by means of a repetitive 'cutting' action which involves swimming on their sides and displacing gravel (Crisp, 2000). A proportion of the female's eggs are then deposited and are subsequently fertilized by the male, before the nest is filled in by additional cutting upstream (Crisp, 2000). The female may spawn in several redds (Klemetsen *et al.*, 2003). The survival of eggs is directly related to the location of the redd.

Eggs incubate in the 'redd' for several months, hatching in the subsequent February-March. The larvae known (or "alevins") live within the gravel, relying on endogenous nutrition from their yolk sac (Milner *et al.*, 2003). When the yolk sac is almost exhausted the fish emerge from the gravel in an event known as 'swim up' and start to feed near the redd (Klemetsen *et al.*, 2003). At this stage *S. trutta* are termed "fry", and this phase is typified by aggressive, territorial behaviour, driven by the need to secure food and shelter (Kalleberg, 1958; Le Cren, 1973). When the fry disperse from the redd site, they adopt feeding stations and defend territories; it is at this stage they are termed "parr" (Elliot, 1994; Crisp, 2000).

6.2 Water Depth

Despite observations of salmonids with their dorsal fins above the surface of the water, they are unlikely to choose to spawn in water which is shallower than their own body depth, approximately 0.2 body lengths (Crisp, 1993). Studies investigating the mean depth of brown trout spawning habitat have shown that redds are generally located in depths from 15cm-45cm (Louhi *et al.*, 2008). Additionally, studies in New Zealand and Canada have also shown the mean depth of redd sites to be within 25.5cm-31.7cm (Shirvell and Dungey, 1983; Witzel and MacCrimmon, 1983).

Furthermore, water depth may be the most influential habitat variable defining spatial segregation among the different life stages of brown trout (Heggenes *et al.*, 1999). Spatial niche selection and abundance of brown trout is strongly influenced by water depth, with

brown trout <70mm often frequenting shallow, slow-flowing, marginal areas <20-30 cm deep (Armstrong *et al.*, 2003). These depths are consistent with nursery areas utilized by brown trout fry after emergence from spawning gravels.

6.3 Substrate Composition

The availability of suitably sized substrate can impact the spawning success and productivity of salmonids in rivers (Kondolf and Wolman, 1993). Substrate size is important as the female needs 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). The main spawning habitat requirements for salmonids, including brown trout are well defined (SFCC, 2007). Brown trout require substrates that are broadly within the gravel, pebble, and cobble range 8-128mm (Ottaway *et al.*, 1981; Armstrong *et al.*, 2003).

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).

Moreover, substrate composition is not solely limited to spawning and can influence each life stage of brown trout. The dispersal of brown trout fry from their spawning gravel after 'swim up' is limited, with a majority residing within a few hundred metres of the spawning site (Crisp, 1996). Trout fry prefer to inhabit areas with a coarse gravel substrate, ranging from 50-70mm in diameter, comparable to that at redd sites (Heggenes, 1988). Furthermore, brown trout fry and parr, prefer a gravel-pebble mix compared to a gravel only substratum (Bardonnet and Heland, 1994). A coarser substrate provides low velocity micro-niches, which fish can use to conserve energy whilst observing invertebrate drift (Bardonnet and Heland, 1994). Moreover, the availability of interstitial spaces, which can be used to avoid predators increases with a coarser substrate (Heggenes *et al.*, 1999). The abundance and diversity of invertebrate prey items increases with the porosity of the available substrate (Maridet *et al.*, 1992). Lastly, coarser substrate may increase visual isolation between the brown trout fry and parr cohort, which serves to reduce agonistic interactions (Kalleberg, 1958).

6.4 Flow Type

The flow type instream characteristic can be used as a proxy of water velocity and plays an important role in salmonid spawning habitat suitability. Crisp and Carling 1989, discovered a lower limit velocity range of 15-20 cm s^{-1} in which salmonids of all sizes did not favour for spawning. This may be due to water velocity impacting on the substrate and as water velocity decreases the substrate type becomes predominantly smaller in size and contains more fine material (Vannote *et al.*, 1980).

Studies examining the mean velocity preferences of brown trout spawning habitats have found velocity ranges between 39.4 cm s^{-1} and 46.7 cm s^{-1} (Shirvell and Dungey, 1983; Witzel and MacCrimmon, 1983). Brown trout may choose high velocities to ventilate the redd or large gravels to improve the structure of the redd, or both. It has been postulated that salmonids use velocity as a surrogate for spawning substrate, which determines reproductive success (Armstrong *et al.*, 2003) The substrate used for spawning is likely to be interdependent with velocity because larger gravels tend to be associated with higher velocities (Kondolf and Wolman, 1993). Consequently, if the water velocity is reduced because of inundation then it would likely also alter the substrate composition.

6.5 Impacts

The transformation of potential optimal spawning habitat, due to the impoundment, is most likely to affect the inflowing tributaries which and subsequent increase in the loch margin, is considered to be a minor impact on brown trout in the context to this catchment system.

The change in habitat will present no net loss of habitat suitable to support life stages of trout. The alteration of habitat within the Allt a' Chaoil-rèidhe and Allt Cam will result in a change of 14% and 4% of the potential spawning habitat to juvenile refugia habitat. This is considered to be relatively minor in relation to the wider availability of spawning habitat that is both accessible and suitable for trout spawning further upstream.

The habitat area estimates, derived from remote sensing data, suggests there whilst there are spawning gravels in the inundation zone, that may be flooded by the increase in the loch area as a result of the impoundment. There are further extensive areas of spawning habitat immediately upstream and along the first 5km of both river systems which is accessible to trout migrating from the loch.

The main areas to be impacted are those immediately adjacent to the loch margin and whilst the substrate is considered to be optimal for spawning, it is also less shading and with less shelter than those further upstream. As such, these potential spawning areas, at the confluence of the loch edge, may be at risk of predation from otters and other predatory birds, using the loch, than those in either the Allt a' Chaoil-rèidhe or Allt Cam, particularly given the wider more open aspect of the spawning gravels at the confluence with Loch Pattack.

There are no visible barriers to upstream migration to additional spawning habitats and as such the increase in the loch margin will transform spawning habitat to juvenile refugia but will not affect the availability or accessibility of upstream spawning habitats further. Any loss of spawning area is considered minor in relation to the availability of similar habitats upstream of the loch margin and within the tributary itself.

Flow regimes altered are likely to affect the River Pattack because the weir would have the potential to restrict the upstream migration of brown trout to the upper reaches of the river and beyond at certain flow regimes.

Based on the previous fish habitat and population report, brook lamprey were not observed in any sampling locations above the grid reference NN 256600 90300 which is located below the falls of Pattack. Therefore, the current Development would not impact on brook lamprey as evidence suggests their absence.

European Eels (*Anguilla anguilla*) were absent from all sites surveyed in the previous report, however, none of these sites looked at the upper reaches of the River Pattack above the location of the proposed Development and beyond. Despite noted barriers in the lower reaches for other fish species, eels are adept at overcoming barriers and can utilise land for short periods to overcome barriers.

6.6 Mitigation

As highlighted the inundation caused by the Development would alter flow, depth, and potential substrate types within the impacted area. This would lead to a change from spawning habitat to brown trout parr habitat in the main tributaries. Therefore, as part of this Development, in the inundated areas, it would be advisable to conduct habitat restoration in order to maximise its potential as juvenile trout habitat.

Restoration works that look to increase the instream complexity of river channels has been shown to, increase the number of trout able to utilise the area, increase individual fitness, reduce energy expenditure, reduced predation, increase food availability, and reduced competitive interactions between trout (Wild Trout Trust, 2022a). This can be achieved by a variety of methods such as restoring riparian vegetation and the addition of instream woody debris (Wild Trout Trust, 2022b). The benefits of such works are the increased survival of trout parr which will impact on the productivity of these brown trout populations.

As previously mentioned, a concern raised by SEPA was the instream migration of fish within the River Pattack downstream of the weir, as a result of altered flow regimes due to the Development. To alleviate this issue, a fish pass could be installed, or the weir periodically lowered to allow upstream and downstream migration of fish, but fish population data would be needed to justify these mitigation measures as it may be disproportionate vs the actual

number of fish migrating from the poor habitat within the upper River Pattack to the Loch and beyond to spawn. In addition, if the 'critically endangered' European eel was found to be present, then a potential solution would be the construction and implementation of eel ladders.

Alternately, the Client could look at enhanced compensatory flow regimes that would enable the upstream migration of brown trout beyond this potential barrier during autumn migration of brown trout spawning (October to December). Furthermore, the client could look to periodically lower the weir during the spawning season of brown trout.

7 Conclusions

Having analysed the five inflowing/outflowing rivers of Loch Pattack and their aforementioned instream characteristics, it is deemed that Allt a' Chaoil-rèidhe and Allt Cam show the most suitable spawning and nursery habitat. In each of the above watercourses there is potential for some alteration of spawning to nursery habitat, primarily as a result of inundation by the impoundment of the loch. However, as the inundation would be limited to a few hundred metres, the scale of the loss would be minimal in contrast to the remaining suitable spawning habitat on each watercourse.

Furthermore, the loss of spawning habitat is likely to be offset by the creation of trout parr habitat. Consequently, this may increase productivity of brown trout populations on both waterbodies.

8 Recommendations

To elucidate on the potential impacts of the Development on salmonid fish spawning and nursery habitat it would be pertinent to conduct pre- and post-construction, fully quantitative electrofishing surveys. This would provide much needed baseline fisheries data, which could be compared for subsequent years, therefore permitting any impacts or changes in fish populations to be documented. Moreover, electrofishing surveys could reveal other species of fish that may be impacted by the Development and permit further mitigation measures to be identified.

It may also be appropriate to undertake aquatic macro-invertebrate surveys above and below the proposed Development. As aquatic macro-invertebrates are sensitive to changes in water quality, they can be utilised as biological indicators, thus reflecting any changes in water quality because of the Development.

Appropriate mitigation measures should be incorporated into the scheme to avoid damage of any downstream watercourses and any resident fish populations.

A suitably qualified / experienced Ecological clerk of works (ECoW) with fisheries experience should be on site for the duration of the construction period.

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Appendix A – Site Maps and Survey Maps

Appendix B – SFCC Habitat Survey Sheet

SFCC HABITAT SURVEY VERSION 2.3																					
PART A: GENERAL SWEEP-UP INFORMATION																					
ID		**River**				**Altitude (m)**		**Date**	- 20 -												
DownstE (m)		**DownstN (m)**		**UpstE (m)**		**UpstN (m)**															
Length (m)		**Water level**	**Circle ONE of the following:** Dry / Low / Medium / High / Spate																		
Surveyor	**Name:** …….. ……. **Accreditation Code:** ……..						**Proprietors**														
PART B: CHANNEL SWEEP-UP DATA																					
Bed visible (%)		**Wet width (m)**		**Bank base width (m)**			**Mature islands (n)**														
WATER DEPTHS (% OF SURVEY STRETCH WETTED AREA)																					
0-20 cm		**21-40 cm**		**41-80 cm**			**>80 cm**														
SUBSTRATE (%OF SURVEY STRETCH WETTED AREA)																					
HO		**SI**		**SA**		**GR**		**PE**		**CO**		**BO**		**BE**		**OB**					
Instream veg (%)		**Silted?**	Y / N				**Iron deposits (%)**														
Substrate	**Circle ONE of each of the following:** Stable / Unstable ***AND*** Compacted / Partly / Uncompacted																				
Substrate notes																					
CHANNEL FEATURES (% OF SURVEY STRETCH LENGTH)																					
Braided channels (%)								**Braids stable?**	Y / N / NA												
Channel feature notes																					
FLOW (% OF SURVEY STRETCH WETTED AREA)																					
SM		**DP**		**SP**		**DG**		**SG**		**RU**		**RI**		**TO**							
Flow notes																					
CANOPY COVER (% OF SURVEY STRETCH WETTED AREA)																					
Canopy cover (%)		**Canopy cover notes**																			
PART C: LEFT BANK (looking DOWNSTREAM) SWEEP-UP DATA																					
BANKSIDE FISH COVER (% OF BANK LENGTH)																					
Fish Cover (%)		**Type**	**Circle ANY of the following:** DR / UC / MA / RT / RK / OTH…….. **OR** NONE																		
Cover Notes																					
GENERAL BANKSIDE STATUS (% OF BANK LENGTH)																					
Riparian buffer zone (m)		**Grazing intensity (bankface & buffer zone)**	**Circle ONE of the following:** None / Light / Moderate / Intense																		
Grazers (bankface & buffer zone)	**Circle ANY of the following:** Deer / Livestock / Rabbits **OR** None																				
Grazing exclusion feature(s) present	**Circle ANY of the following categories OR 'None':** Deer fence / Stock fence / Wall / Hedge / Rabbit mesh / Other ..... **OR** None																**Exclusion upgrade required (m)**				
Predominant bankface vegetation	**Circle ONE of the following:** Bare / Uniform / Simple / Complex																				

Predominant buffer zone vegetation	**Circle ONE of the following:** Bare / Uniform / Simple / Complex						
Collapse (%)	**Severe**:…… **Moderate**:…….. **Light**:……..			**Erosion (%)**	**Severe**:…… **Moderate**:…… **Light**:……..		
Trampling (%)	**Severe**:…….. **Moderate**:…….. **Light**:……			**Bankside notes**			
Side bars (%)		**Side bars stable?**	Y / N / NA	**Point bars (%)**		**Point bars stable?**	Y / N / NA
RIPARIAN ZONE							
Overhanging boughs (% of bank length - trees and shrubs)		**Predominant overhanging trees**	**Circle ONE of the following:** Deciduous / Evergreen / None				
Predominant land use (50m from banktop)	**Circle ONE of the following:** BL / CO / OR / MH / SC / TH / RP / IG / TL / WL / OW / SU / RS / RD / AR / NC / FW / IN / GA						
Other land uses (50m from banktop)	**Circle ANY of the following EXCLUDING category already circled above OR 'NA':** BL / CO / OR / MH / SC / TH / RP / IG / TL / WL / OW / SU / RS / RD / AR / NC / FW / IN / GA **OR** NA						
Presence of young plantations	**Circle ANY of the following:** Deciduous / Coniferous / Mixed **OR** None						
Conifer planting conforms to F&W guidelines	Yes / No / NA	**Riparian notes**					

ID		**River**		**Date**	- 20 - V2.3

PART D: RIGHT BANK (looking DOWNSTREAM) SWEEP-UP DATA

BANKSIDE FISH COVER (% OF BANK LENGTH)							
Fish Cover (%)		**Type**	**Circle ANY of the following:** DR / UC / MA / RT / RK / OTH..... **OR** NONE				
Cover Notes							
GENERAL BANKSIDE STATUS (% OF BANK LENGTH)							
Riparian buffer zone (m)		**Grazing intensity (bankface & buffer zone)**	**Circle ONE of the following:** None / Light / Moderate / Intense				
Grazers (bankface & buffer zone)	**Circle ANY of the following:** Deer / Livestock / Rabbits **OR** None						
Grazing exclusion feature(s) present	**Circle ANY of the following categories OR 'None':** Deer fence / Stock fence / Wall / Hedge / Rabbit mesh / Other ..... **OR** None				**Exclusion upgrade required (m)**		
Predominant bankface vegetation	**Circle ONE of the following:** Bare / Uniform / Simple / Complex						
Predominant buffer zone vegetation	**Circle ONE of the following:** Bare / Uniform / Simple / Complex						
Collapse (%)	**Severe**:…….. **Moderate**:…….. **Light**:……..			**Erosion (%)**	**Severe**:…… **Moderate**:…… **Light**:……..		
Trampling (%)	**Severe**:…….. **Moderate**:…….. **Light**:……			**Bankside notes**			
Side bars (%)		**Side bars stable?**	Y / N / NA	**Point bars (%)**		**Point bars stable?**	Y / N / NA
RIPARIAN ZONE							
Overhanging boughs (% of bank length - trees and shrubs)		**Predominant overhanging trees**	**Circle ONE of the following:** Deciduous / Evergreen / None				
Predominant land use (50m from banktop)	**Circle ONE of the following:** BL / CO / OR / MH / SC / TH / RP / IG / TL / WL / OW / SU / RS / RD / AR / NC / FW / IN / GA						
Other land uses (50m from banktop)	**Circle ANY of the following EXCLUDING category already circled above OR 'NA':** BL / CO / OR / MH / SC / TH / RP / IG / TL / WL / OW / SU / RS / RD / AR / NC / FW / IN / GA **OR** NA						
Presence of young plantations	**Circle ANY of the following:** Deciduous / Coniferous / Mixed **OR** None						
Conifer planting conforms to F&W guidelines	Yes / No / NA	**Riparian notes**					

PART E: SWEEP-UP PHOTOGRAPHS

PART F: POLLUTION POINTS

ID		**Easting**		**Northing**		**Time**	
Type	**Select ONE of the following:** SE / FE / SD / IN / FR / RD / ?? / OTH				**Status**	Potential / Actual	
Dead fish?	Y / N	**Photos**		**Contact**			
Notes							

PART G: OBSTACLES

ID		Easting		Northing	
Type	Select ANY of the following: WF / DA / WE / CU / BR / FP / FC / FD / FT / GC/ WG / OTH			Pass?	Select ONE of the following: No (U/D) / No (U) / Yes (S/F) / Yes / ??
Vertical?	Y / N / NA	E-fishing required?	Y / N	Photos	Contact
Notes					

PART H: CHANNEL / BANK MODIFICATIONS

ID		Easting		Northing		Location	Select ANY: Left Bk / Right Bk / Bed
Type	Circle ANY of the following: GA / CW / HP / FP / CR / CD / RE / UC / OTH				Effectiveness	Circle ONE of the following: Effective / Ineffective / Not known	
Downstream effect ?	Y / N	Approx. age	..... / Not known	Previous attempts	0 / 1 / 2 / > 2 / Not known		
Length (m)		Photos		Contact			
Notes							

PART I: SPAWNING LOCATIONS

ID		Easting		Northing		Area (m2)		Useable (%)	
Suitability (G/P)	SA..... TR.....		Washout (Y/N/?)		Notes				

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D ON PAGE .....

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D | ***PAGE .....***

ID		River		Date	- 20 -	V2.3

PART F: POLLUTION POINTS

ID		Easting		Northing		Time	
Type	Select ONE of the following: SE / FE / SD / IN / FR / RD / ?? / OTH				Status	Potential / Actual	
Dead fish?	Y / N	Photos		Contact			
Notes							

ID		Easting		Northing		Time	
Type	Select ONE of the following: SE / FE / SD / IN / FR / RD / ?? / OTH				Status	Potential / Actual	
Dead fish?	Y / N	Photos		Contact			
Notes							

PART G: OBSTACLES

ID		Easting		Northing	
Type	Select ANY of the following: WF / DA / WE / CU / BR / FP / FC / FD / FT / GC/ WG / OTH			Pass?	Select ONE of the following: No (U/D) / No (U) / Yes (S/F) / Yes / ??
Vertical?	Y / N / NA	E-fishing required?	Y / N	Photos	Contact
Notes					

ID		Easting		Northing	
Type	Select ANY of the following: WF / DA / WE / CU / BR / FP / FC / FD / FT / GC/ WG / OTH			Pass?	Select ONE of the following: No (U/D) / No (U) / Yes (S/F) / Yes / ??
Vertical?	Y / N / NA	E-fishing required?	Y / N	Photos	Contact
Notes					

PART H: CHANNEL / BANK MODIFICATIONS

ID		**Easting**		**Northing**		**Location**	**Select ANY:** Left Bk / Right Bk / Bed
Type	**Circle ANY of the following:** GA / CW / HP / FP / CR / CD / RE / UC / OTH			**Effectiveness**	**Circle ONE of the following:** Effective / ineffective / not known		
Downstream effect ?	Y / N	**Approx. age**	..... / Not known	**Previous attempts**	0 / 1 / 2 / > 2 / Not known		
Length (m)		**Photos**		**Contact**			
Notes							

ID		**Easting**		**Northing**		**Location**	**Select ANY:** Left Bk / Right Bk / Bed
Type	**Circle ANY of the following:** GA / CW / HP / FP / CR / CD / RE / UC / OTH			**Effectiveness**	**Circle ONE of the following:** Effective / ineffective / not known		
Downstream effect ?	Y / N	**Approx. age**	..... / Not known	**Previous attempts**	0 / 1 / 2 / > 2 / Not known		
Length (m)		**Photos**		**Contact**			
Notes							

PART I: SPAWNING LOCATIONS

ID		**Easting**		**Northing**		**Area (m2)**	**Useable (%)**
Suitability (G/P)	**SA**..... **TR**.....		**Washout (Y/N/?)**		**Notes**		
ID		**Easting**		**Northing**		**Area (m2)**	**Useable (%)**
Suitability (G/P)	**SA**..... **TR**.....		**Washout (Y/N/?)**		**Notes**		
ID		**Easting**		**Northing**		**Area (m2)**	**Useable (%)**
Suitability (G/P)	**SA**..... **TR**.....		**Washout (Y/N/?)**		**Notes**		

POLLUTION, OBSTACLES, MODIFICATIONS AND SPAWNING CONT'D ON PAGE .....

Figure 4: SFCC Habitat Survey Sheet

Appendix C – Survey Stretch Photographs

Plate 1: Survey Stretch 1 - Coachan Bàn

Plate 2: Survey Stretch 2 - Coachan Bàn

Plate 3: Survey Stretch 1 - Allt a' Chaoil-rèidhe

Plate 4: Survey Stretch 2 - Allt a' Chaoil-rèidhe

Plate 5: Survey Stretch 1 - Coachan Ruadh

Plate 6: Survey Stretch 1 – Allt Cam

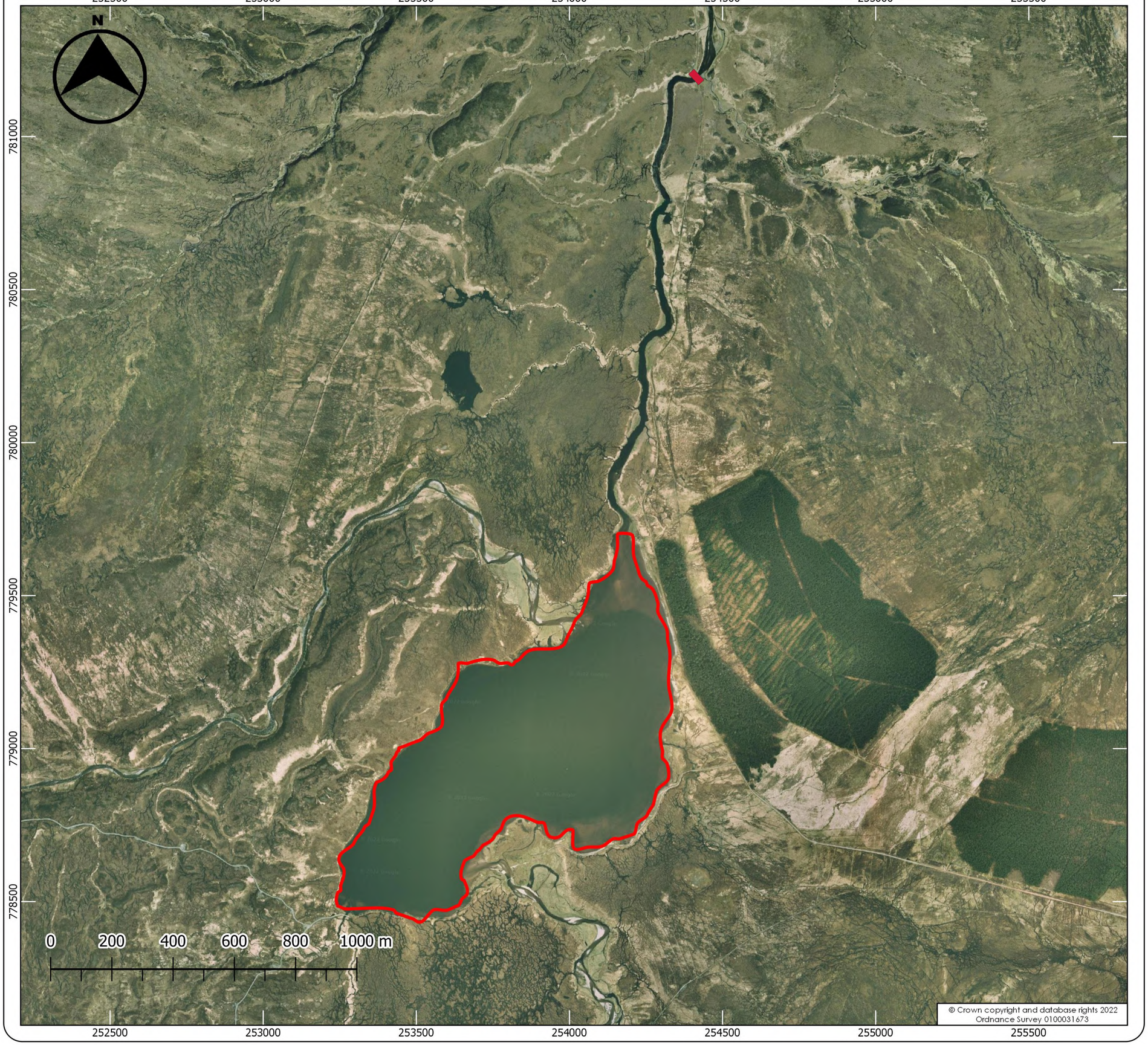
Plate 7: Survey Stretch 2 – Allt Cam

Plate 8 Survey Stretch 1 – River Pattack

Plate 9: Survey Stretch 2 – River Pattack

Plate 10: Survey Stretch 3 – River Pattack

Plate 11: Survey Stretch 4 – River Pattack



Legend

- site boundary
- Variable Weir Proposed Development

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 1: location on the River Pattack of the proposed weir

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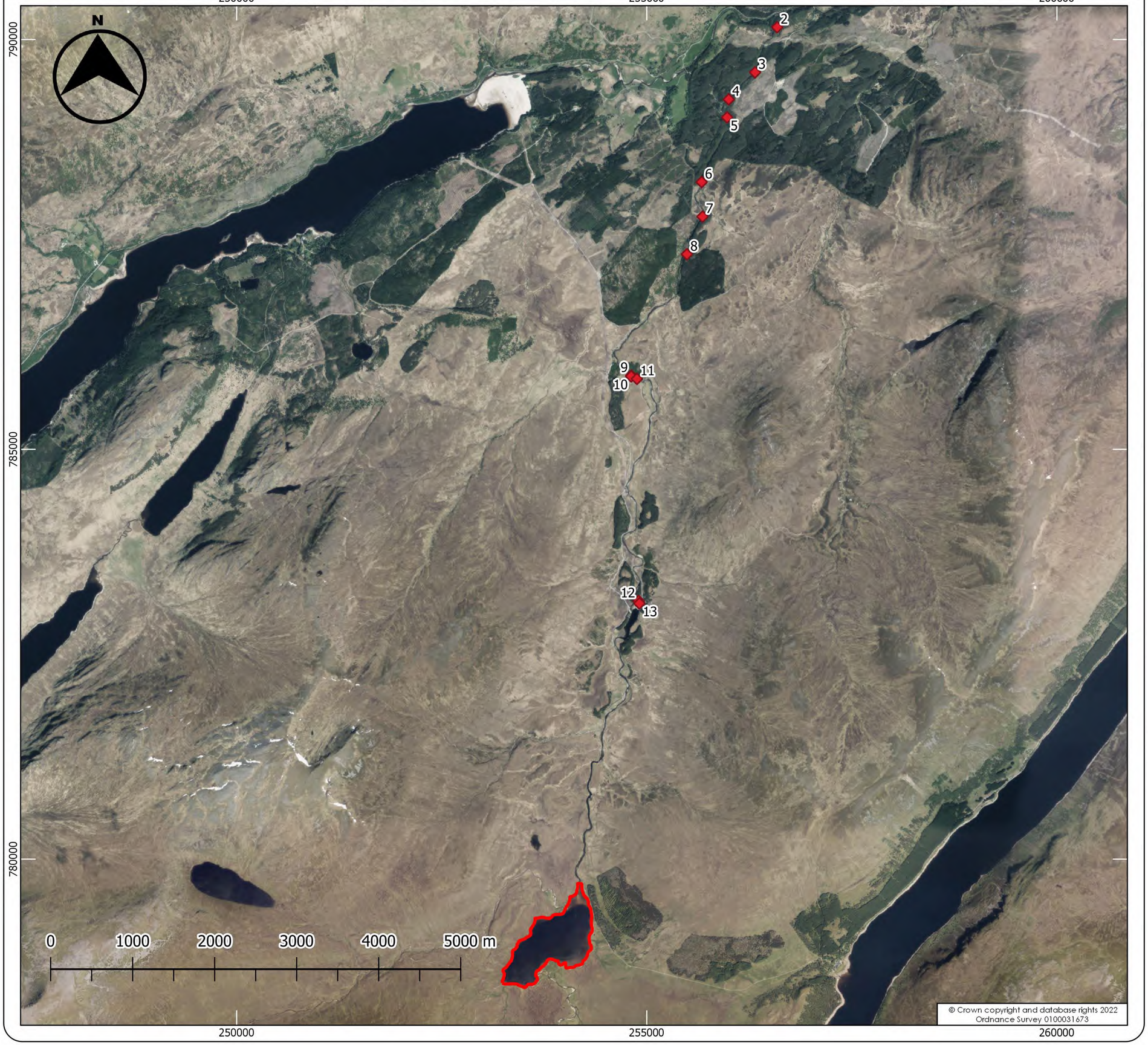

Legend

site boundary

Fish Migration Barriers

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 2: Fish migration barriers on the River Pattack

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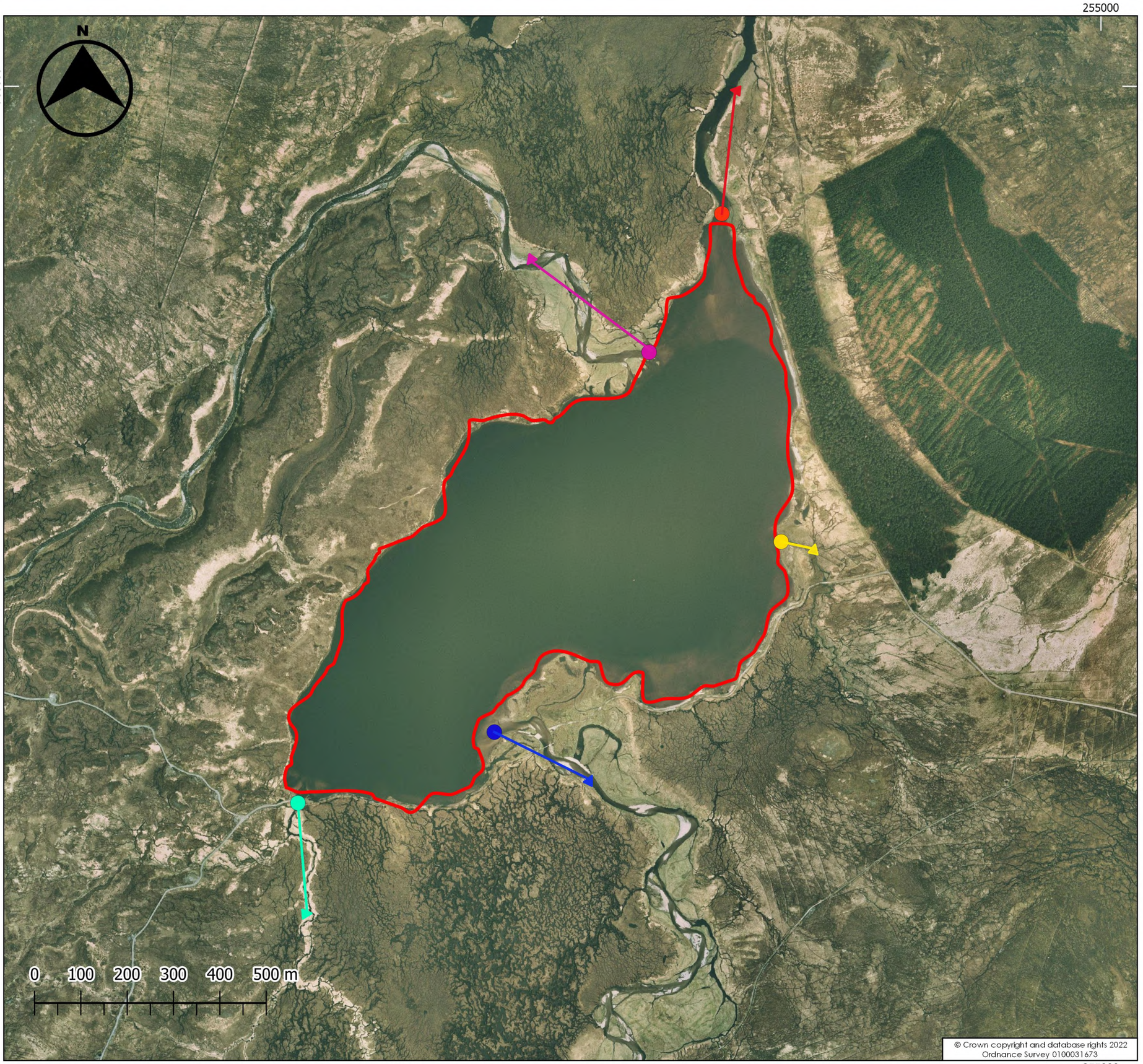

Legend

- site boundary
- Coachan Bàn
- Coachan Ruadh
- River Pattack
- Allt a' Chaoil-rèidhe
- Allt Cam

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 3: Walkover habitat assessments locations

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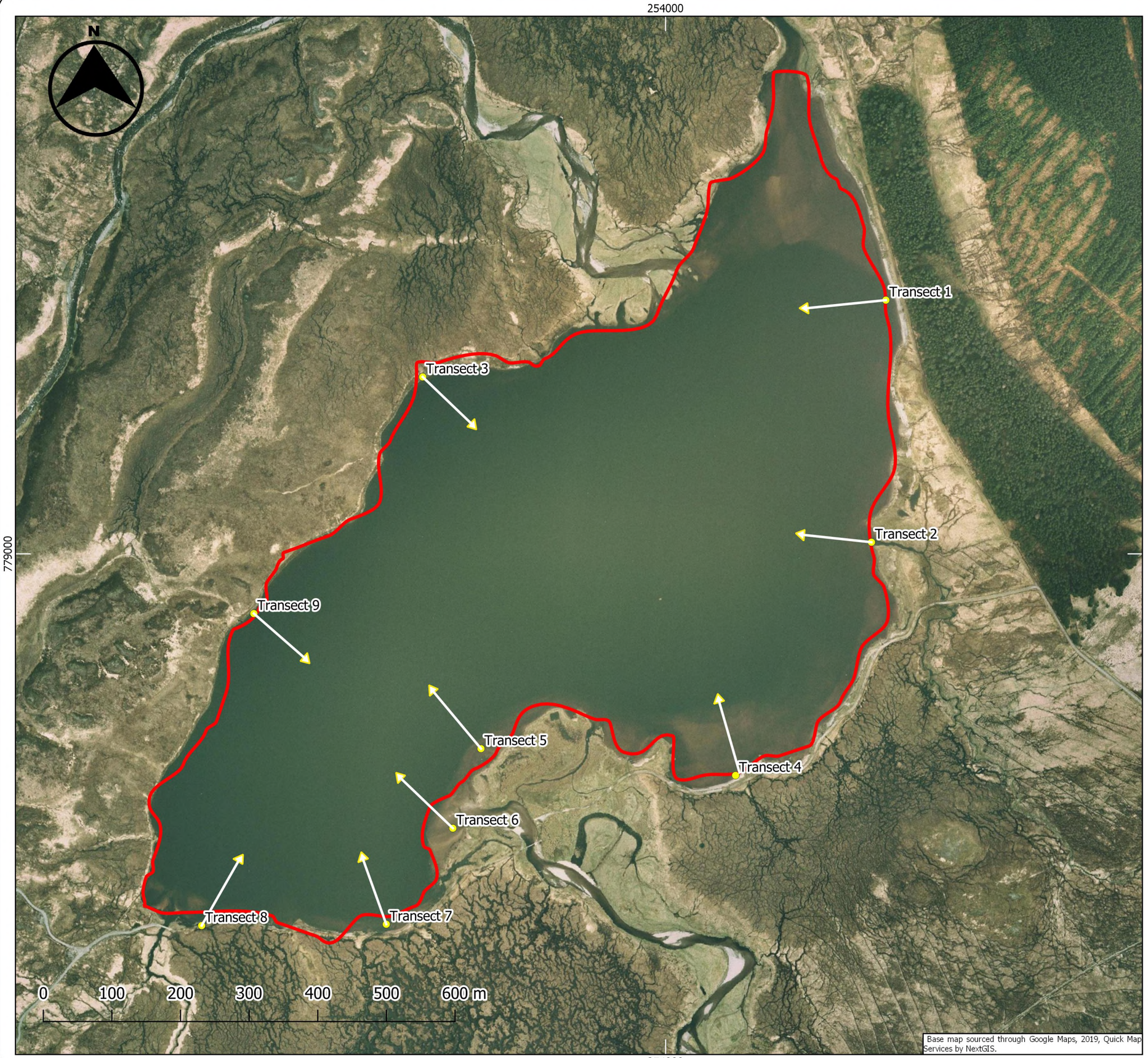

Legend

site boundary

Transect Start Locations

Transect Number	X	Y
Transect 1	254321	779370
Transect 2	254300	779017
Transect 3	253646	779258
Transect 4	254102	778677
Transect 5	253731	778716
Transect 6	253690	778600
Transect 7	253593	778460
Transect 8	253324	778458
Transect 9	253400	778913

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 5: Boat transects on Loch Pattack

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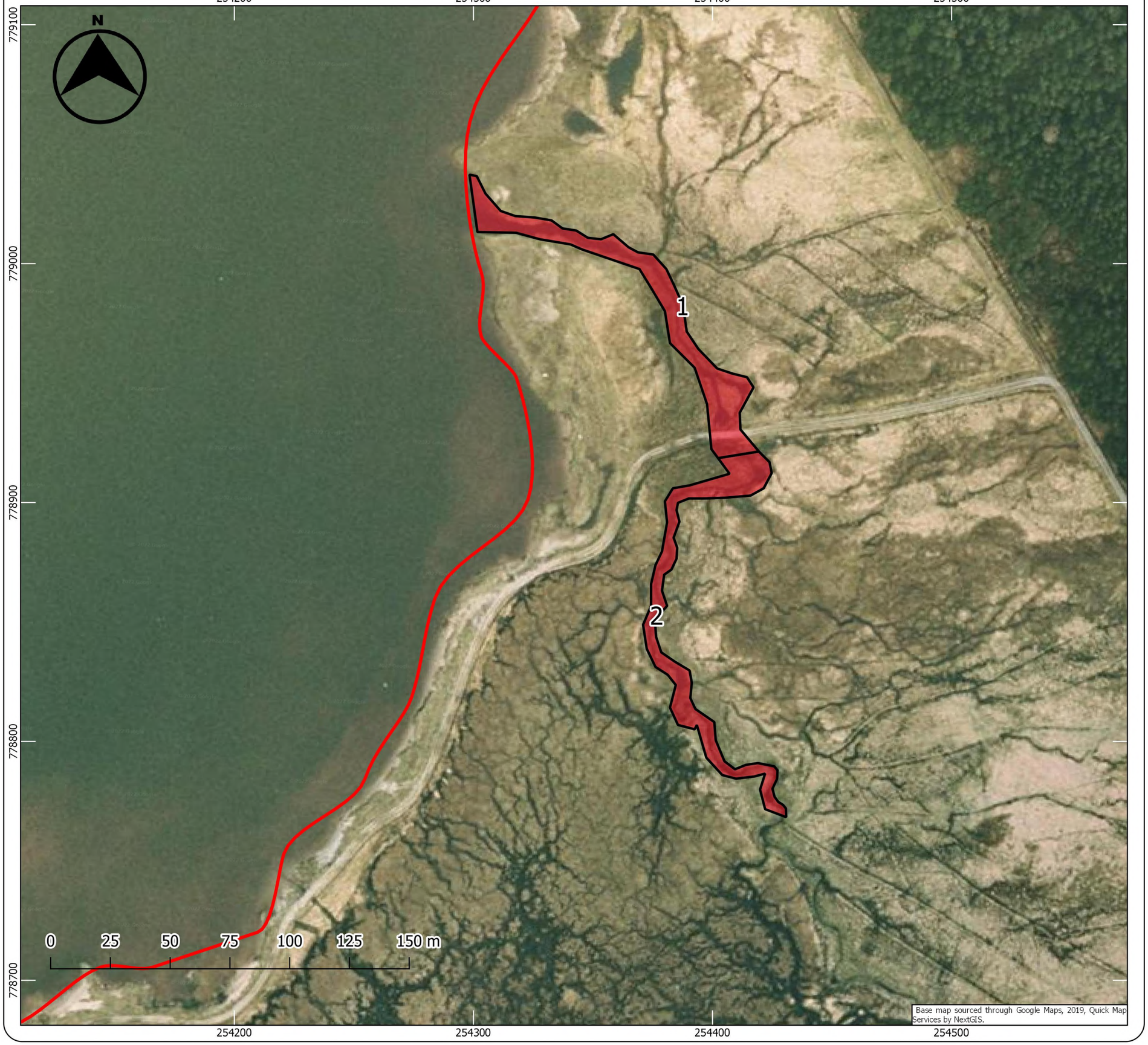

Legend

- site boundary
- Watercourse (Lebeling indicative of section number)

Habitat Suitability Key

- Unsuitable
- Sub Optimal
- Optimal
- N/A

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 6: Coachan Bàn Fish Habitat Walkover Assessment

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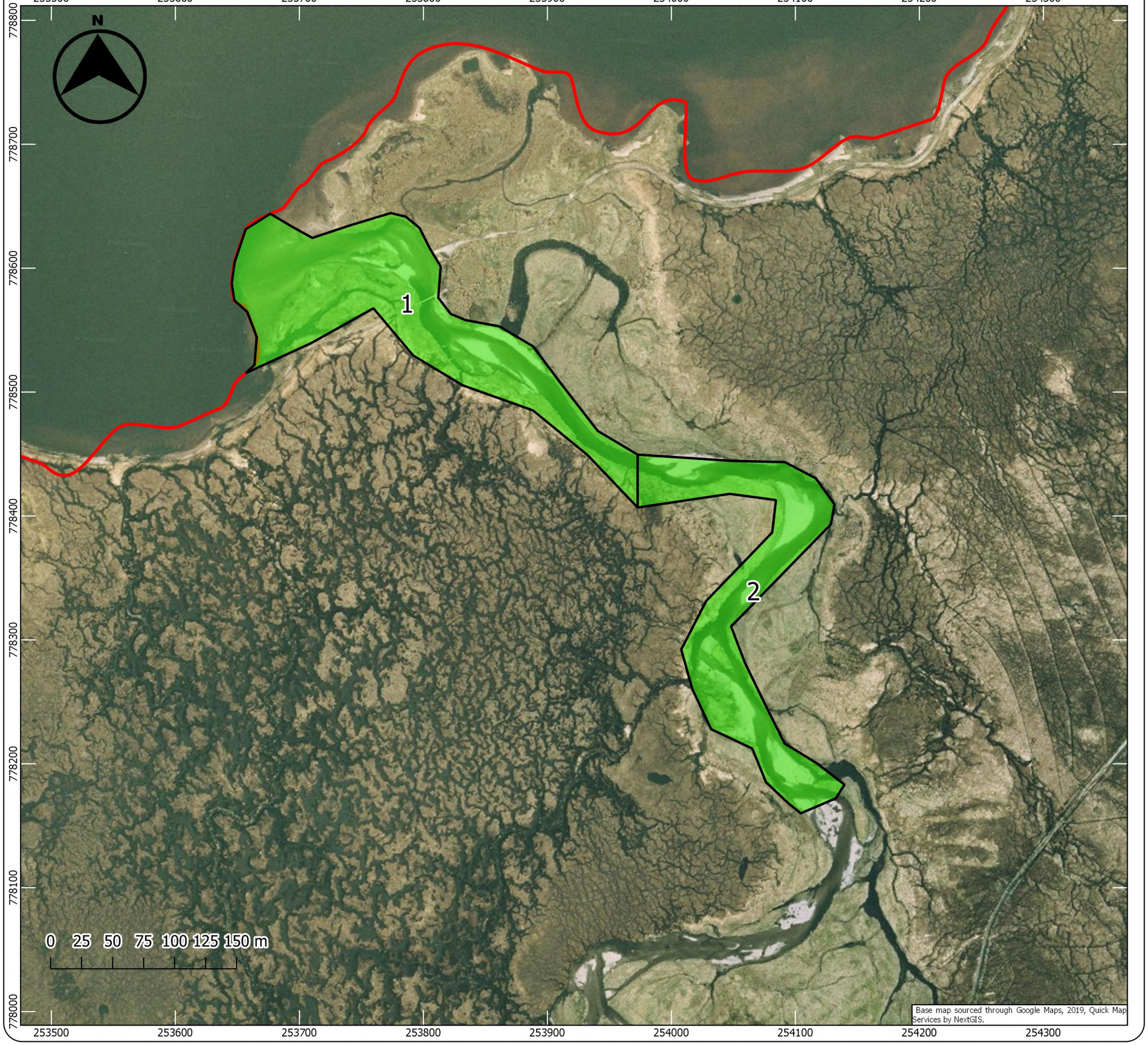

Legend

- site boundary
- Watercourse (Lebeling indicative of section number)

Habitat Suitability Key

- Unsuitable
- Sub Optimal
- Optimal
- N/A

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 7: Allt a' Chaoil-rèidhe Fish Habitat Walkover Assessment

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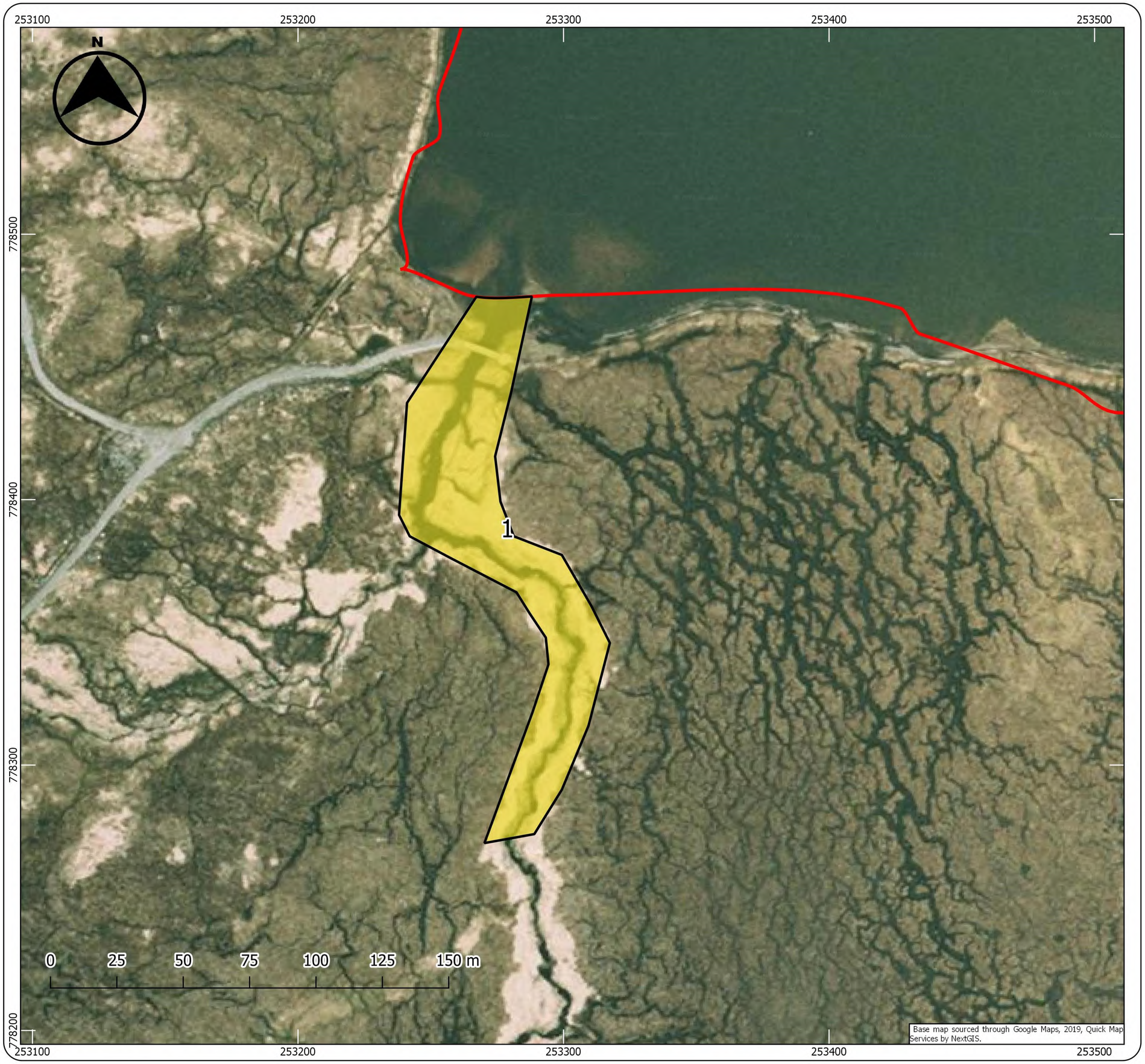

Legend

- site boundary
- Watercourse (Lebeling indicative of section number)

Habitat Suitability Key

- Unsuitable
- Sub Optimal
- Optimal
- N/A

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 8: Coachan Ruadh Fish Habitat Walkover Assessment

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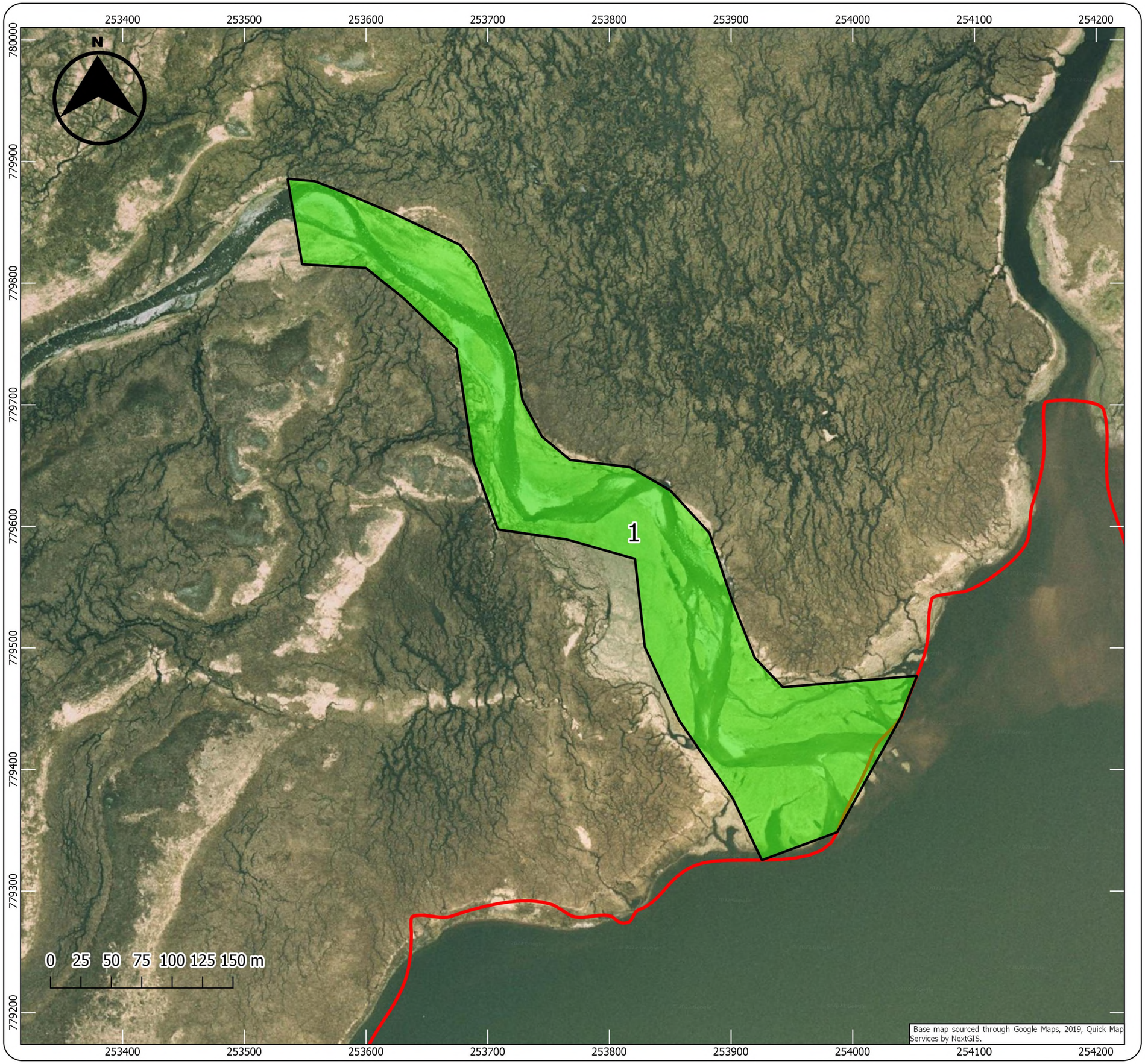

Legend

- site boundary
- Watercourse (Lebeling indicative of section number)

Habitat Suitability Key

- Unsuitable
- Sub Optimal
- Optimal
- N/A

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 9: Allt Cam Fish Habitat Walkover Assessment

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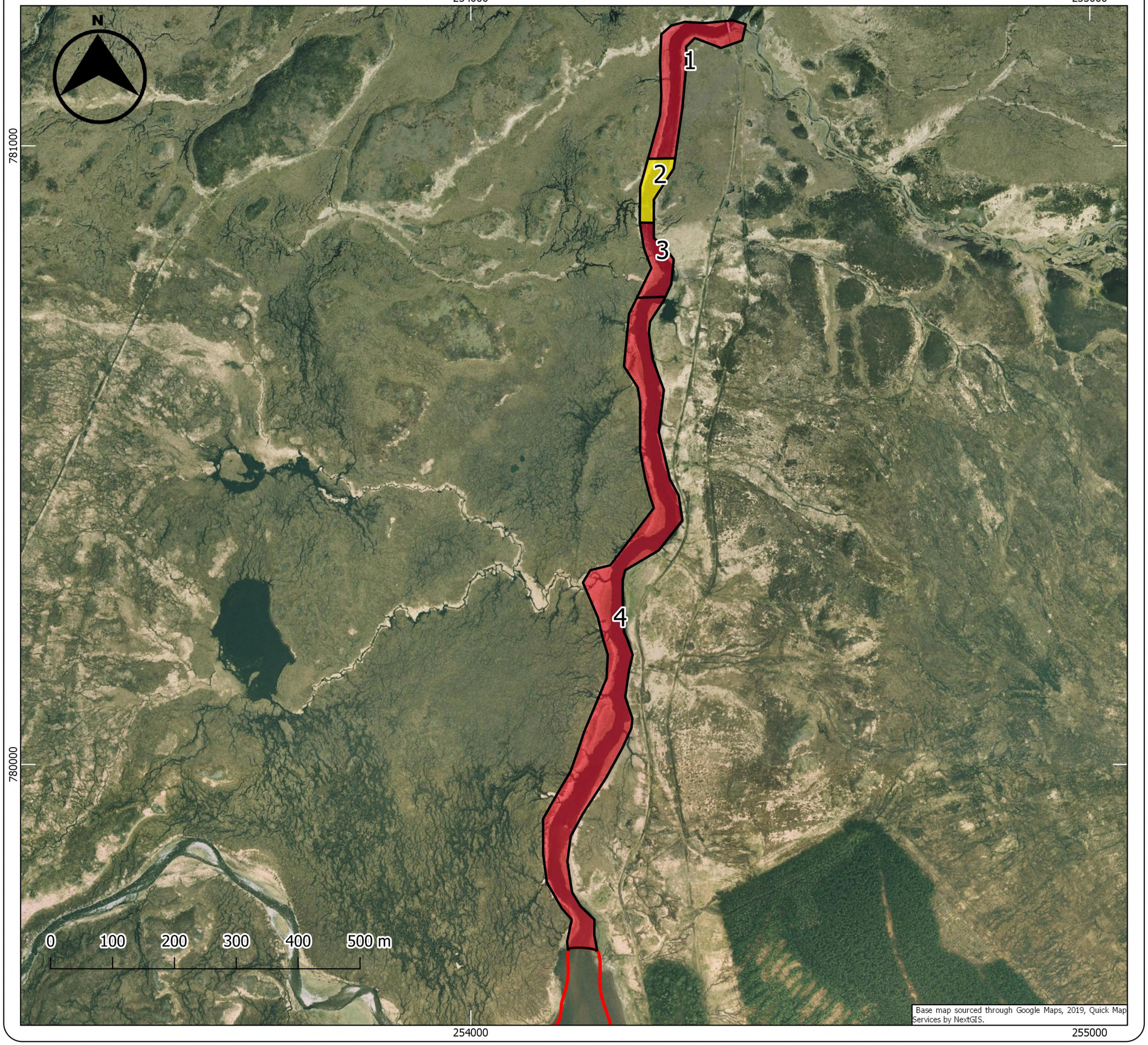

Legend

- site boundary
- Watercourse (Lebeling indicative of section number)

Habitat Suitability Key

- Unsuitable
- Sub Optimal
- Optimal
- N/A

Project Number:
P22018

Project Title:
Loch Pattack Fish Surevys

Client:
Gilkes Energy

Figure Title:
Figure 10: River Pattack Fish Habitat Walkover Assessment

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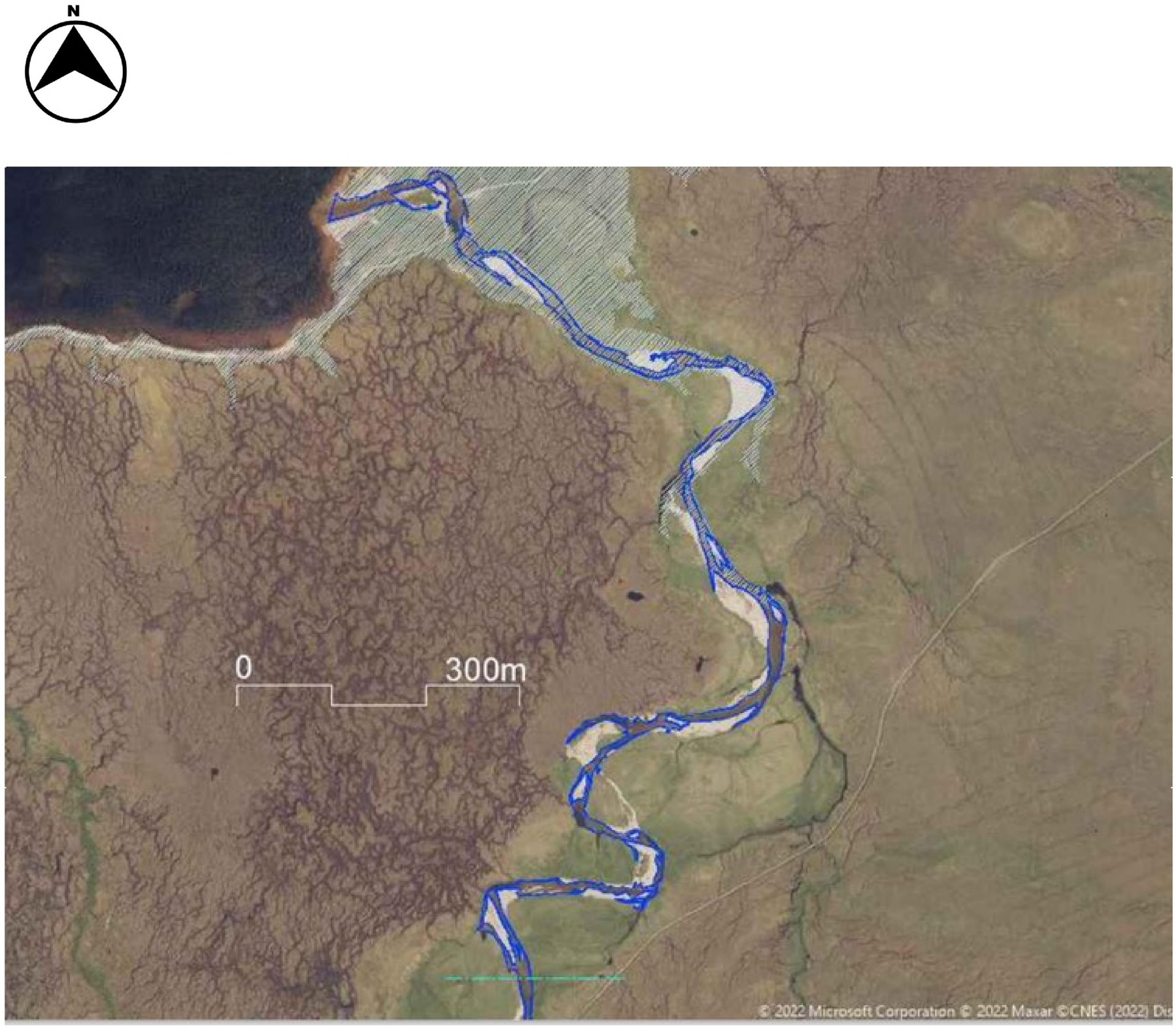

Legend

- Optimal spawning zone
- inundation maximum extent
- inundation zone

Project Number: 22018

Project Title: Loch Pattack (PF)

Client:Gikes Energy

Figure Title:
AC - A

Status:	Revision:	Page Size:
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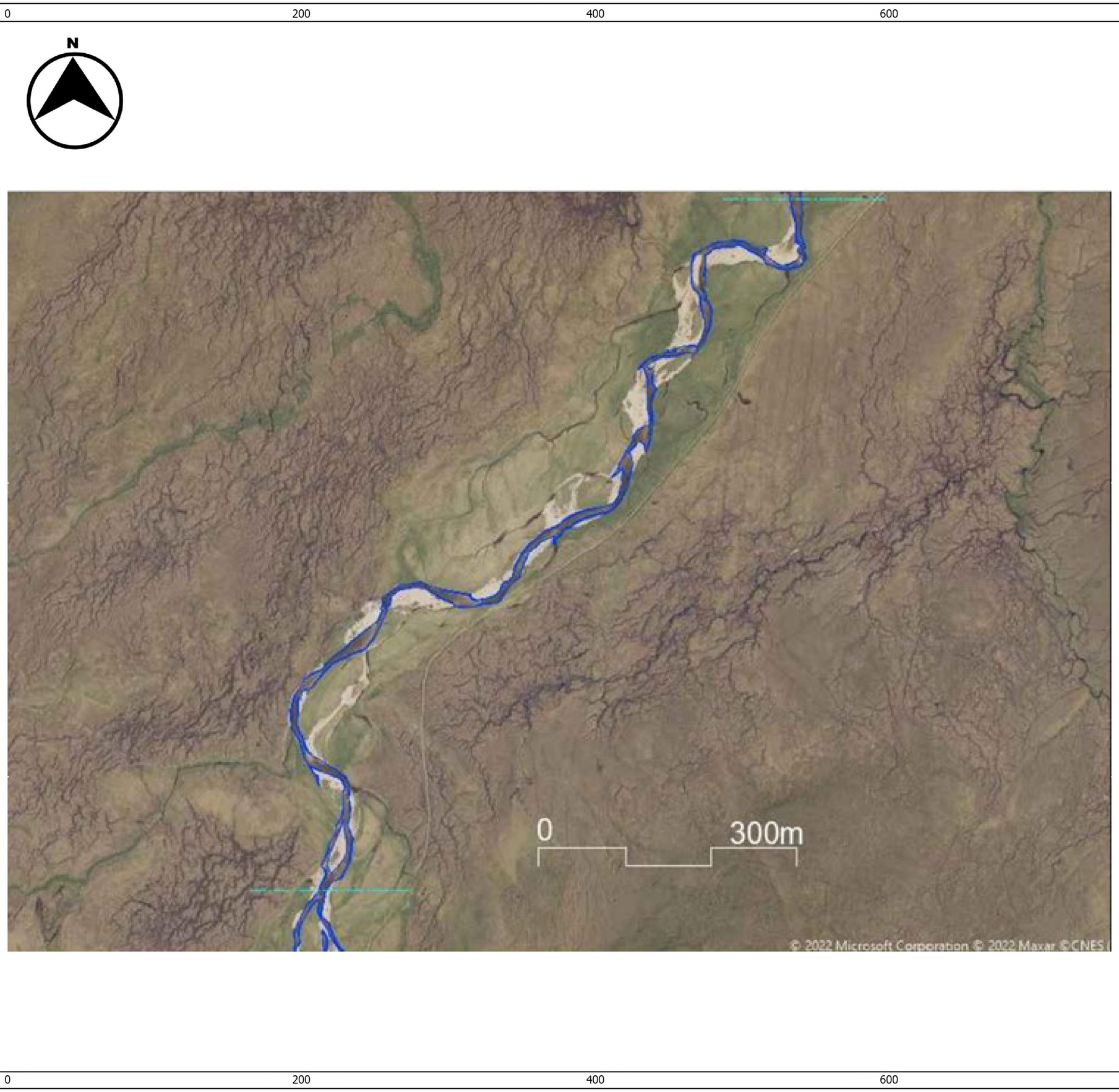

Legend

- Optimal spawning zone
- inundation maximum extent
- inundation zone

Project Number: 22018

Project Title: Loch Pattack (PF)

Client:Gikes Energy

Figure Title:
AC - B

Status:	Revision:	Page Size:
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Legend

- Optimal spawning zone
- inundation maximum extent
- inundation zone

Project Number: 22018

Project Title: Loch Pattack (PF)

Client:Gikes Energy

Figure Title:
AC - C

Status:	Revision:	Page Size:
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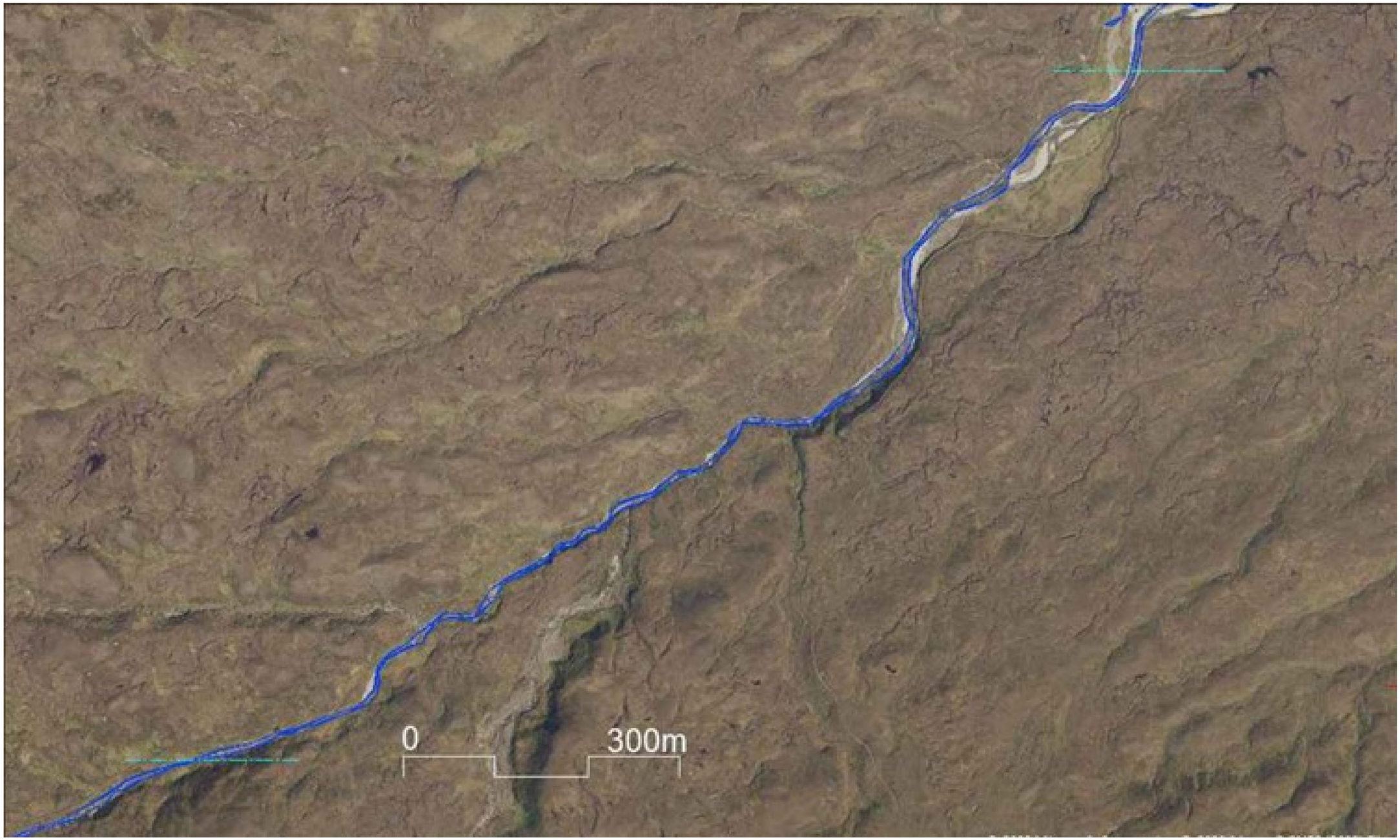

— Optimal spawning zone — inundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC - D		
Status: Final	Reviewed: [redacted]	Page Size: A3
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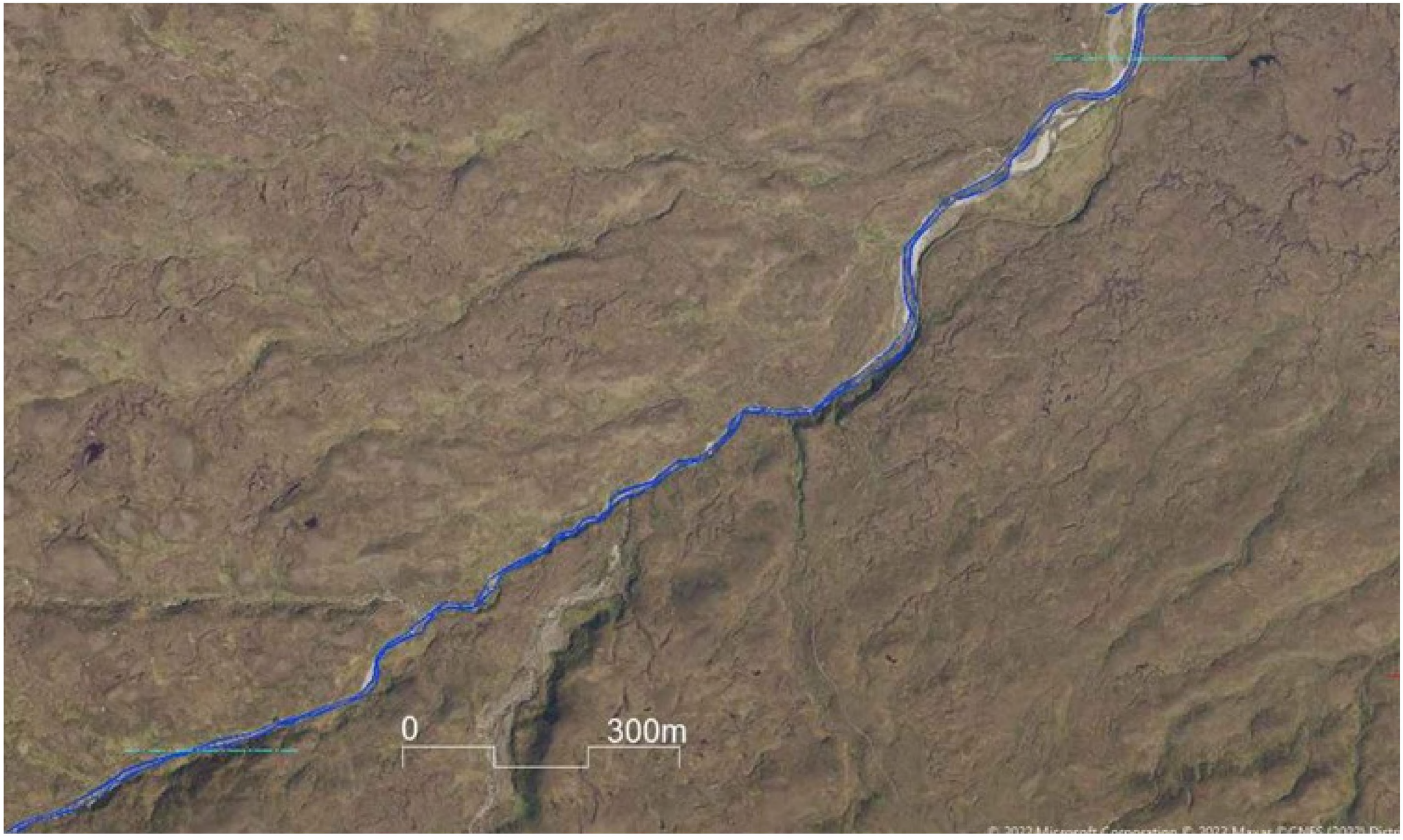

— Optimal spawning zone — inundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC - E		
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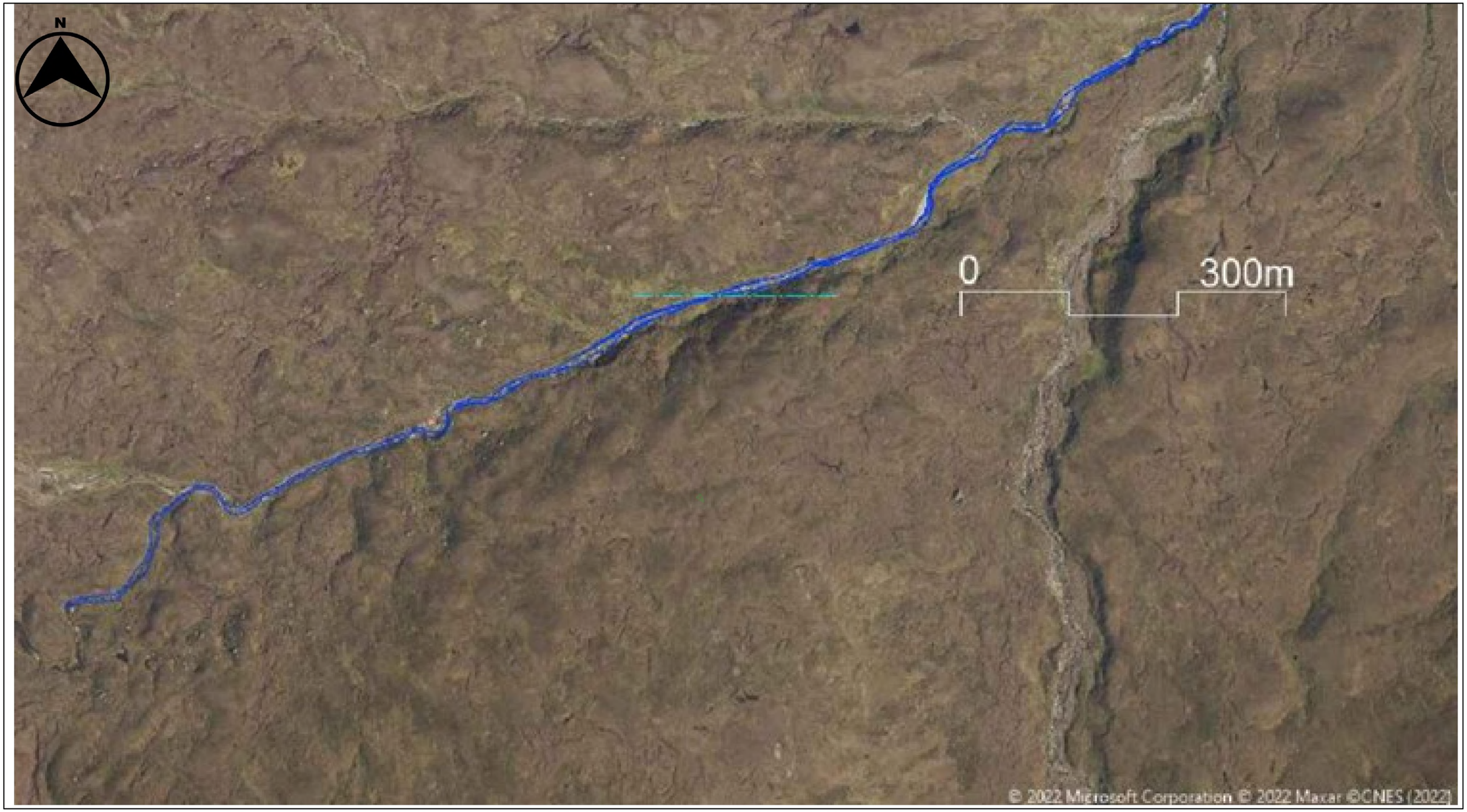

— Optimal spawning zone — inundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC - F		
Status: Final	Reviewed: [redacted]H	Page Size: A3
Drawn: [redacted]	Revision: 1	Date: 10/03/2022

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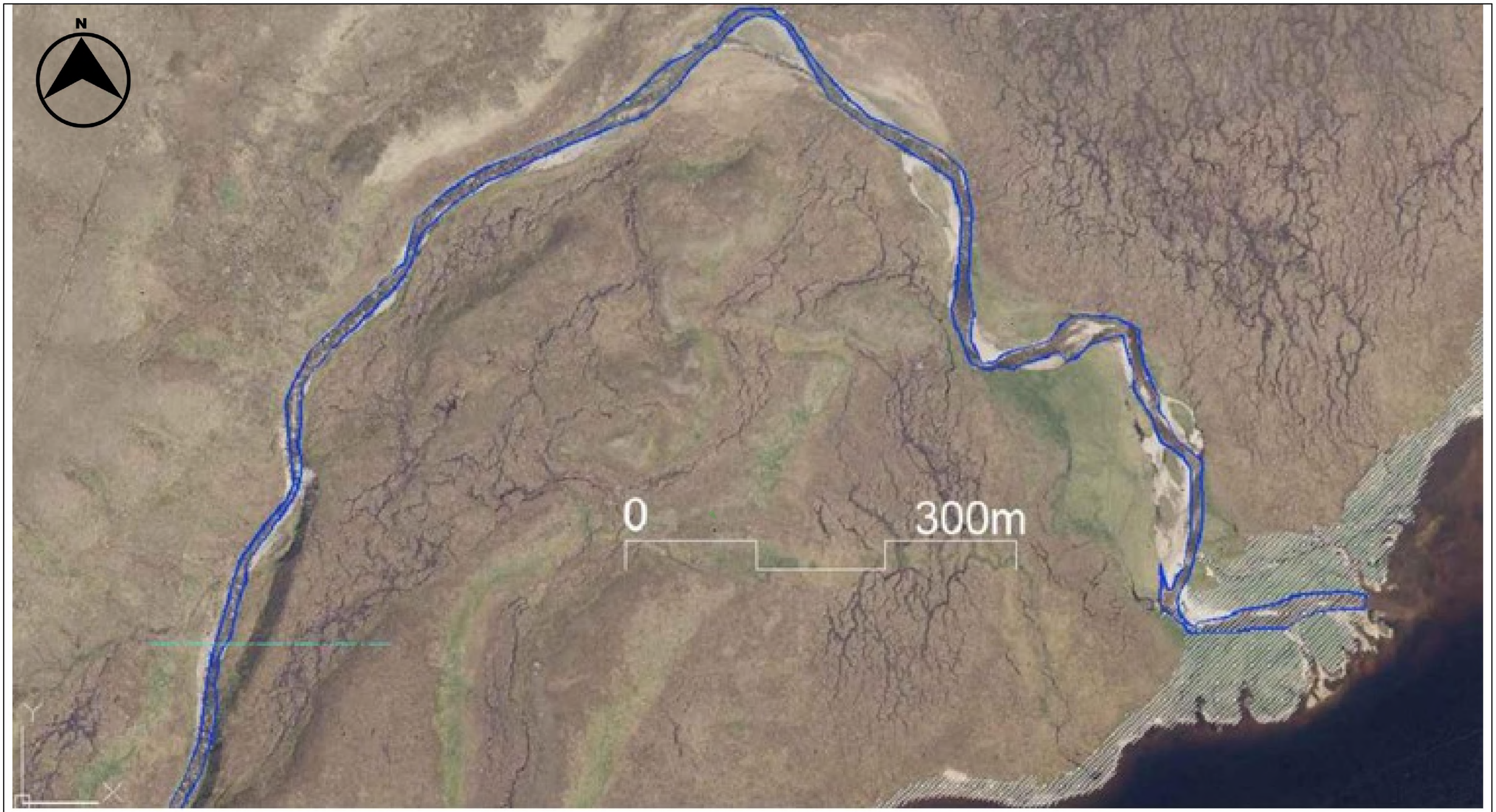

— Optimal spawning zone — Innundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC1		
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Drawn: [redacted]	Revision: 1	Date: 10/03/2022

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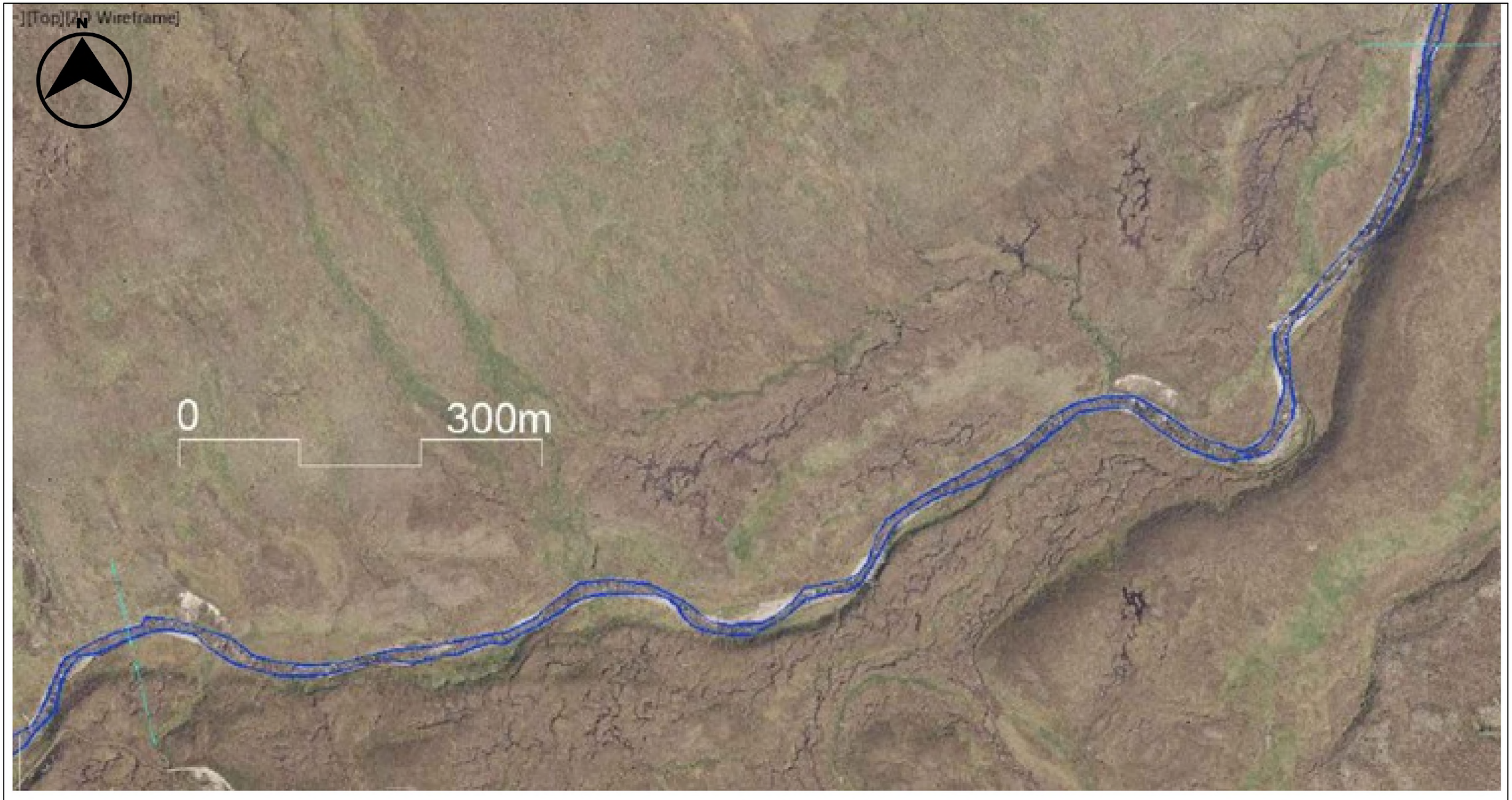

— Optimal spawning zone — Innundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC2		
Status: Final	Reviewed: A[redacted]	Page Size: A3
Drawn: [redacted]	Revision: 1	Date: 10/03/2022

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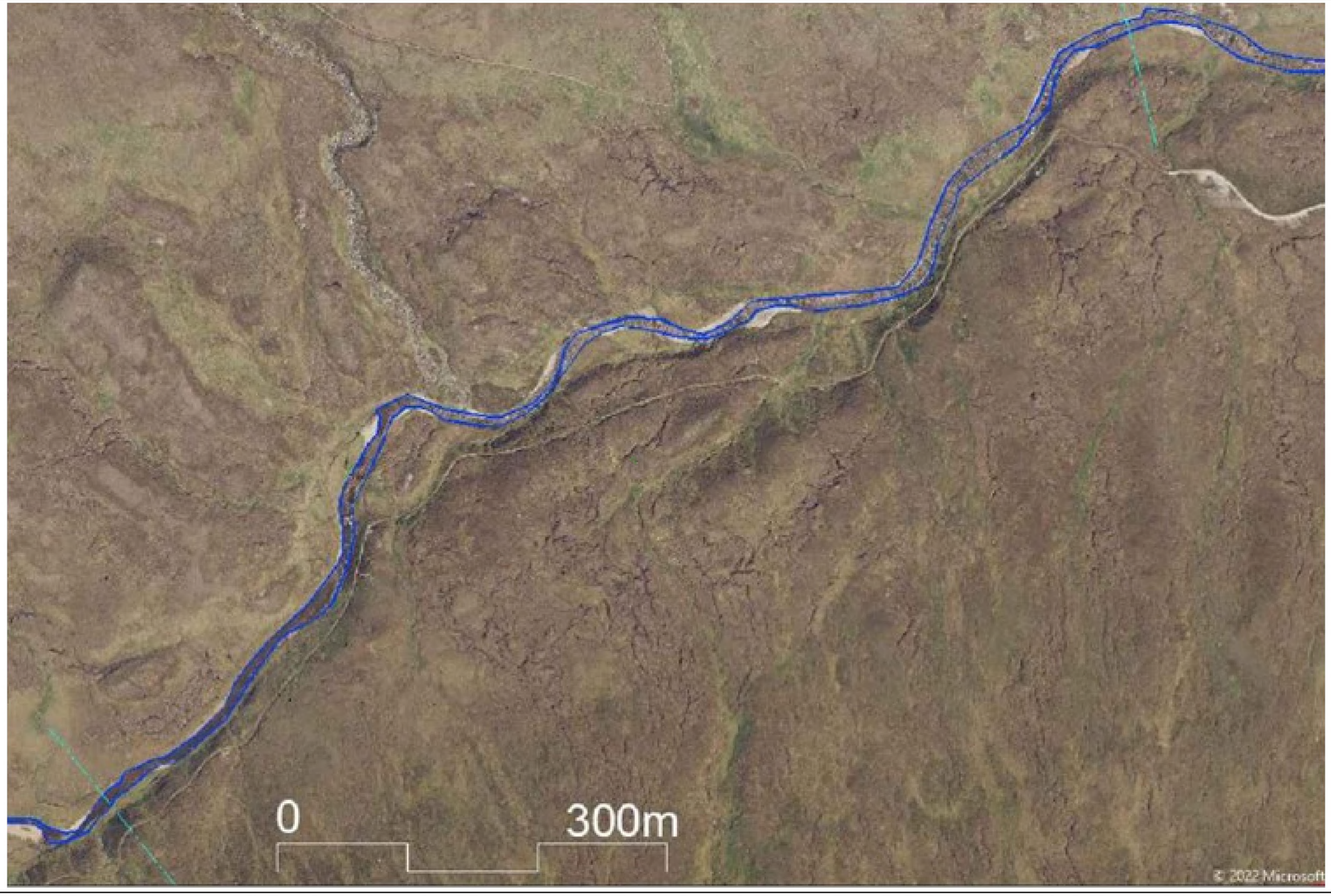

— Optimal spawning zone — Innundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC3		
Status: Final	Reviewed: [redacted]	Page Size: A3
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— Optimal spawning zone — Innundation maximum extent ▨ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC4		
Status: Final	Reviewed: [redacted]	Page Size: A3
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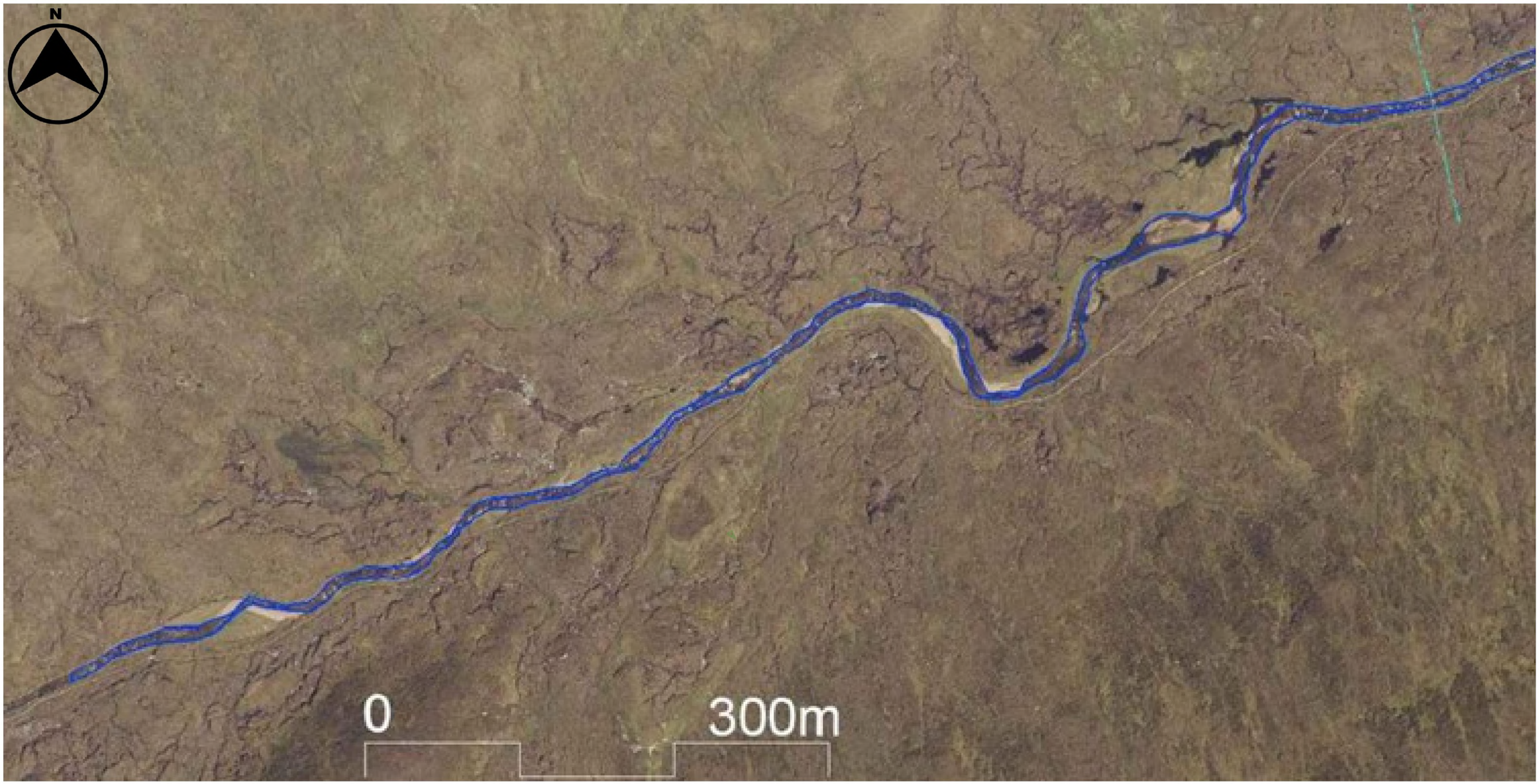

— Optimal spawning zone — Innundation maximum extent ⊠ Inundation zone

Client: Gikes Energy		
Project Number: 22018		
Project Title: Loch Pattack (PF)		
Figure Title: AC4		
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