Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

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Basis of Report

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Executive Summary

SLR Consulting ('SLR') was appointed by Renewable Energy Systems Ltd (RES) ('the applicant') to undertake surveys including fish habitat assessments (including salmonid spawning potential) and fully quantitative electrofishing surveys to determine the presence of fish species at the proposed nineteen turbine wind farm development at Longcroft ('the proposed development'). The site of the proposed development is located north-east of the A697, approximately 8.5km north-north-east of Lauder in the Scottish Borders. The site is within the administrative boundary of Scottish Borders Council, and located within the Tweed catchment.

Using previous data and recommendations from August 2023 fish habitat assessments, recommendations for electrofishing sites were used and full quantitative electrofishing surveys were undertaken in September 2023. Fish habitat quality was undertaken both within (T3a, T5-T8, T10) and outwith (T1, T3b, C1) the site and at/adjacent to targeted water crossing sites (T5, T6). All potential water crossing points are within the Whalplaw Burn. Fish habitat quality ranged from: Good (T3a, T3b, T6, T7, T10, C1); and Moderate (T1, T5, T8). No habitat surveyed in September 2023 was identified at the time to be deemed High, Poor or Low habitat quality. Salmonid spawning potential ranged from Optimal (T3b, T6, T7, C1); and Sub-Optimal (T1, T3a, T5, T8, T10). No habitat from September 2023 survey was deemed Not Suitable for potential salmonid spawning habitat. No redds were identified.

Both Atlantic salmon and brown/ sea trout were present across survey locations within the site. Atlantic salmon parr (1++) were only present on the Whalplaw Burn below the in-river barrier (2m height) observed in September 2023 surveys. This barrier was deemed impassable under low water conditions due to the rock formation which is most likely why salmon were not present within the most upper reaches of the Whalplaw Burn within the site at survey locations T5 and T6 . Atlantic salmon fry (0+) were present at survey locations only within Soonhope Burn (T7, T8; within the site) at locations with undercut banks, where more prominent and faster waters were observed. Trout fry (0+) and parr (1++) were present across all electrofished survey locations. It is most likely that the trout found within the Whalplaw Burn above T3a are unlikely to migrate to sea due to the instream barrier. In addition, only trout were found at survey location T10 where migrating is likely to be impeded by a culvert. Thus, all trout found within Whalplaw Burn and above the culvert are most likely to remain as brown resident trout.

No suitable eel habitat was found across all surveyed locations, as undercut banks were very shallow, and there was lack of rock formation providing suitable hiding substrate. Lamprey habitat was found at the control site (C1) where sand substrate in large patches was found to have residing river lamprey and where fast water flow was present.

Based on the results of this report it is recommended that:

- The proposed development has been designed to minimise the number of watercourse crossing points and that the proposed development is sufficiently distant (>50m) from watercourses.

- Pollution prevention measures will require to be employed during the construction process and a suitable water quality programme established to ensure that the construction phase does not impact on the fish habitats.

- Construction and post-construction fish fauna monitoring programme will require to be carried out utilising the same nine (control site included) fish fauna sites as part of an ongoing assessment of potential impacts which may occur due to the proposed development. The suggested monitoring schedules are as follows: Fish fauna surveys annually during construction (summer/early autumn) and post-construction Year 1 (summer/early autumn) and Year 2 (summer/early autumn).

- Macroinvertebrate sampling is recommended to be conducted at all nine survey locations. The purpose of this macroinvertebrate data is to provide a longer-term water quality monitoring that can be compared and monitored over the duration of the project and to

demonstrate biodiversity recovery post construction. Baseline ecological condition for watercourses will be used as an indicator of overall watercourse health over time.

- A pre-construction, construction and post-construction water quality monitoring programme is carried out as part of an ongoing assessment of potential impacts, which may occur due to the proposed development. This will help to protect the aquatic assemblage throughout the proposed development and in the long term, highlighting where impacts may be occurring, and mitigation can be designed to address accordingly. It will also provide evidence of the scale of impact on the surrounding watercourses from any pollution incidents which may or may not be directly related to the proposed development.

- A suitably qualified / experienced Environmental Clerk of Works (ECoW) should be on site, periodically, for the construction phase of the proposed development.

- Design the proposed development to avoid potentially increasing erosion or vibrations that may result in further erosion and explore opportunities to enhance riparian corridor (e.g., wet woodland planting).

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Acronyms and Abbreviations

SEPA	Scottish Environment Protection Agency
SFCC	Scottish Fisheries Coordination Centre
OS	Ordnance Survey
SEW	Scotland's Environmental Web
FLS	Forestry and Land Scotland
RBMP	River Basin Management Plan
CPUE	Catch per Unit Effort
FHQ	Fish Habitat Quality
SSP	Salmonid Spawning Potential

1.0 Introduction

1.1 Background

SLR Consulting ('SLR') was appointed by Renewable Energy Systems Ltd (RES) ('the applicant') to undertake surveys including fish habitat assessments (including salmonid spawning potential) and fully quantitative electrofishing surveys to determine the presence of fish species at the proposed nineteen turbine wind farm development at Longcroft ('the proposed development'). The 'site' refers to all land within the site, as displayed in **Figure 8.5.1.**

The applicant intends to submit an application to the Scottish Government Energy Consents Unit under Section 36 of the Electricity Act 1989 to develop a renewable electricity generating station, including a wind farm and battery energy storage system, at Longcroft, located within the Scottish Borders. The proposed development is based on a layout of 19 wind turbines with a tip height of 220m, associated wind turbine foundations, crane crane hardstands, access tracks, substation compound and battery energy storage system compound. A range of temporary construction phase features will also be developed, including borrow bits, construction compounds and laydown areas.

The site of the proposed development is located north-east of the A697, approximately 8.5km north-north-east of Lauder in the Scottish Borders. The site is within the administrative boundary of Scottish Borders Council, located within the Tweed catchment **(Figure 8.5.1)**.

1.2 River Basin Management Plan

The European Union's Water Framework Directive (WFD) requires all inland and coastal waters within defined river basin districts to reach at least 'good' ecological status/potential by a set deadline[1]. The Scottish Government committed to continued alignment with European Union (EU) standards and laws following EU exit[2]. SEPA is the lead authority to ensure compliance with WFD requirements. With input from responsible authorities and other stakeholders, SEPA has coordinated the production of the Scotland River Basin Management Plan (RBMP) to ensure the protection, improvement and sustainable use of the water environment for future generations. The overall aim is for 98% of Scotland's waters to be in a good condition by 2027, to be progressively implemented through three RBMP cycles (2009-2015; 2015-2021 and 2021-2027)[3].

The RBMP has identified the following key pressures on the water environment in Scotland:

- Morphological alterations (e.g., modifications to beds, banks and shores as the result of historical engineering and urban development);
- Diffuse source pollution (e.g., agriculture, urban development);
- Point source pollution (e.g., the discharge of sewage, manufacturing and quarrying);
- Abstraction and flow regulation (e.g., alterations to water flows and levels as the result of electricity generation and public water supplies); and
- Invasive non-native species RBMPs set out how organisations, stakeholders and communities will work together to improve the water environment.

[1] EU Water Framework Directive (2000) - Directive 2000/60/EC (Accessed online – 29/08/2023)

[2] UK Withdrawal from the European Union (Continuity) (Scotland) Act 2021 (legislation.gov.uk)

[3] https://www.sepa.org.uk/media/163445/the-river-basin-management-plan-for-the-scotland-river-basin-district-2015-2027.pdf (Accessed online – 29/08/2023)

1.3 Study Objectives

The objectives of this report were to:

- Undertake baseline fish habitat assessments within/outwith the site where there is potential for impact on the aquatic environment during construction and operation to identify potential important ecological features;
- To put watercourses into context to that of the wider riverine environment;
- Identify potential spawning areas for salmonids (Atlantic salmon (*Salmo salar*)/ sea trout/ brown trout (*Salmo trutta*) and lamprey (*Lampetra fluviatilis/ Lampetra planeri*);
- Identify the potential presence of protected/notable/ invasive species;
- Use the baseline information for future comparison studies, potentially required during the construction and post-construction phases of the proposed development;
- Undertake fully quantitative electrofishing assessments of moderate to good habitat; and
- To provide recommendations/ mitigation measures for the proposed development.

1.4 Salmonids

Habitat requirements differ across salmonid species life stages (Atlantic salmon and brown/sea trout), which has been subjected to considerable research[4,5,6,7]. Salmonids return to their natural rivers and spawn in late autumn and early winter, depositing eggs in redds which females excavate in gravel and pebble substrate. Spawning depths range from 5 – 90cm[8], though the selected habitat is based on flow type and substrate composition as opposed to depth. Areas of riffle, run and glides where accelerated flow is present is where eggs are often deposited, where high amounts of O_2 is supplied, essential of egg development. Fine sediment such as silt and fine sand reduces water flow and O_2 supply, resulting in egg mortality. Egg survival is also affected by redd 'washouts' during winter spates – the direct, physical, scouring out of eggs from the gravel. Substrate stability, the dynamics of water flow and the weather all determine the extent of siltation and washouts. Over the course of three/four months (385–545 degree days) the eggs hatch into alevins, though, this time frame is highly dependent on environmental factors such as temperature. Alevins emerge from the gravel redds (often in March to early May) to feed on macro-invertebrates, they are then referred to as "fry", where they passively drift downstream or remain in the vicinity of the redd. Salmon fry prefer fast flowing waters i.e. riffles (>20cm/s) with surface turbulence, requiring pebble, cobble and gravel substrate. However, trout prefer low velocity water, near the stream bed with slower flow rates. Cover from stones, plants or debris is required and good cover is essential for maintaining high fry densities.

Usually by the second year in streams, fry develop into "parr", becoming much larger over time after utilizing feeding opportunities in the stream. Environmental factors such as water temperature and food availability determine the temporal variability in which individuals remain in the parr phase. Parr are found to prefer deeper water (approximately 15 -40cm) and coarser substrate, consisting of pebbles, cobbles, and boulders. Trout parr prefer low water velocity areas where cover is available,

[4] Crisp, D.T. 1993. The environmental requirements of salmon and trout in fresh water. *Freshwater Forum*, 3(3): 176-201.

[5] Hendry, K & Cragg-Hine, D. 2003. *Ecology of the Atlantic Salmon*. Conserving Natura 2000 Rivers Ecology Series No. 7, English Nature, Peterborough.

[6] Klemetsen, A., Amundsen, P-A, Dempson, J.B., Jonsson, B., Jonsson, N., O'Connell, M.F. and Mortensen, E. 2003. Atlantic salmon Salmo salar L., brown trout Salmo trutta L. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. *Ecology of Freshwater Fish*, 12, 1-19.

[7] Youngson, A & Hay, D. 1996 *The Lives of Atlantic Salmon. An illustrated account of the life-history of Atlantic salmon*. Swan Hill Press, Shrewsbury.

[8] Neary, J.P. 2006. *Use of Physical Habitat Structure to Assess Stream Suitability Upland Scottish Streams*. Ph.D. Thesis, University of Stirling, October 2006.

often being found alongside the banks, in undercut banks and amongst margin vegetation and exposed tree roots.

1.5 Lamprey

In April to May, adult lamprey migrate upstream, often during night hours to spawn, extruding their eggs into a redd (nest) in the riverbed, consisting of pebble and gravel substrate, though substrate densities and types have been found to vary between species. Brooke lamprey (*Lampetra planeri*) have been found to spawn in areas of coarse sand and gravel whilst river lamprey (*Lampetra fluviatilis*) selects sites with larger substrate types (gravel, pebble and cobble). The eggs hatch into young larvae, known as ammocoetes and drift downstream from the redd, utilising the current to settle in nursey habitat which consists of fine, soft substrate (mud/sand) in well oxygenated, slow flowing waters. Ammocoetes feed on fine particulate matter such as diatoms, algae and bacteria, spending several years before metamorphosing from larval to adult form. At larvae stage, Brooke and river lamprey are not distinguishable, though once transformed it becomes possible to distinguish between them on the basis of morphology and colouration[9]. Both species of lamprey are known to be poor swimmers, so when migrating upstream for spawning it can be easily disrupted by relatively low vertical barriers.

1.6 European Eel

Eels migrate from saltwater to freshwater environments (catadromous freshwater fish) though spawn in saltwater, taking place in the Sargasso Sea, but the exact location has never been found. The fertile eggs float with the oceanic currents before developing into leptocephali. The migration back to Europe utilising only oceanic currents can take up to two years allowing for morphological changes to occur to pre-adapt juvenile eels for freshwater environments, developing into the glass eel stage.

Glass eels use tides to carry themselves upstream once the coastline is reached. At around 8cm juvenile eels migrate upstream in-search for suitable residing habitat (coarse substrate and gravel, undercutting banks, tree roots). Once within the freshwater environment, glass eels transition into yellow eels, which is the longest life stage ranging from 5 – 20 years, though dependent of sex, recourses and temperature. Upon reach adequate size and fat storage, yellow eels transform into silver eels. The morphological changes (change colour, pectoral fins widen, digestive tract shut down, eyes grow up to 10 times their original size and muscle mass increase) pre-adapts the silver eel to return to the Sargasso Sea to start the cycle again.

2.0 Methodology

2.1 Project Personnel

Table 1 details all personnel involved in aquatic assessments of the proposed development.

Table 1. Project Personnel

Personnel	Role
Amy Green	Project Ecologist
Niamh Ni Nagy	Assistant Ecologist
Leigh Kelly	Mhor Environmental Ltd (subcontractor) - Director

[9] Gardiner, R. 2003. *Identifying Lamprey. A field key for Sea, River and Brook lamprey*. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

2.2 Desk Study

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

- Bing Maps[10] – to obtain aerial imagery to inform field surveys and access suitability to survey along steep slope;
- Ordnance Survey Map[11] – to obtain maps for the area covered by the proposed development and to inform survey location and gradient limitations;
- Scotland's Environment Web (SEW)[12] – to obtain data on obstacles to fish migration on affected watercourses and to determine expected species within the surrounding location (~2 km area boundary);
- Scottish Environment Protection Agency (SEPA)[13] – to review information on the SEPA Water Classification Hub regarding the classification status of watercourses with potential to be affected by the development; and
- NatureScot[14] – to perform a search to identify survey locations with relevant qualifying interests within 2 km of the proposed development.

2.3 Survey Locations

Table 2 provides a list of all survey locations for fish habitat assessments in September 2023 conducted by SLR Project Ecologists and provide justification for site allocation.

Table 2. Survey locations for 2023 aquatic assessments of Longcroft wind farm.

Waterbody	Survey Location	Upstream	Downstream	Justification for Surveying
Cleekhimin Burn	T1	NT 52751 53606	NT 52735 53555	Confluence of Soonhope Burn and Whalplaw Burn. Outside of the site.
Whalplaw Burn	T3a	NT 53703 54534	NT 53678 54510	Moved T4 to T3a to capture the following tributaries; Thorny Cleugh, Foxes Cleugh, Gladescleugh Burn. Inside of the site.
Whalplaw Burn	T3b	NT 52956 53837	NT 52933 53815	Downstream point of Whalplaw Burn. Outside of the site.
Whalplaw Burn	T5	NT 54411 55870	NT 54406 55845	Potential of full extent run off from borrow pit and from T4, T15 and T16. Water crossing point. Inside the site.
Whalplaw Burn	T6	NT 54914 56593	NT 54926 56563	Potential of full extent run off from borrow pit and from T15 and T16. Water crossing point. Inside the site.
Soonhope Burn	T7	NT 53206 55643	NT 53166 55614	Potential of full extent run off from T17 and T18. Inside the site.
Soonhope Burn	T8	NT 53028 54725	NT 53004 54679	Potential of full extent run off from T19. Full scale pollution impact areas for Soonhope Burn. Inside the site.

[10] Bing Maps. (2022). Search. [Online] Available at: https://www.bing.com/maps/

[11] Ordnance Survey Maps. (2023). Maps. [Online] Available at: https://shop.ordnancesurvey.co.uk/maps/ [Accessed 29/08/2023]

[12] Scotland's Environment Web. (2022). Search Scotland's Environment Map. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed 29/08/2023]

[13] Scottish Environment Protection Agency. (2022). SEPA Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed 29/08/2023]

[14] NatureScot. (2022). Map Search. [Online] Available at: https://sitelink.nature.scot/map [Accessed 29/08/2023]

Waterbody	Survey Location	Upstream	Downstream	Justification for Surveying
Jocks Burn	T10	NT 56500 56293	NT 56514 56262	Potential of full extent run off from borrow pit and T6, T5 and T3. Inside the site.
Kelphope Burn	C1	NT 50759 54338	NT 50780 54312	Control site outside of the site to capture potential environmental changes within the catchment area.

2.4 Electrofishing Assessments

Electrofishing surveys were conducted across three days from 26th to 28th September 2023 by two experienced and SFCC qualified team leads (Leigh Kelly and Amy Green), supported for health and safety purposes (working in and near water) by one surveyor in training. Electrofishing was conducted using an EF-500B-SYS Electric Fishing Backpack System and single anode. Electrofishing surveys were led by Leigh Kelly BA MRes (licence holder - CMS-18-102) and in full accordance with SFCC protocols. Weather conditions on the day of sampling were moderate (light rain/ clear) with an ambient temperature of 13°C. Survey locations were determined prior to revisiting the site using fish habitat assessment data collected and reported by SLR Consulting Ltd in August 2023 (See **Annex A**).

2.4.1 Fully Quantitative Assessments

Fully quantitative methods were adopted at survey locations; T3a, T3b, T5, T6, T7, T8, T10 and C1. Fully quantitative surveys use a multiple run approach (3 runs) and estimates of fish abundance were based on fish depletion during successive runs. Fully quantitative surveys are area based and calculate the number of fish per 100m² as per SFCC guidelines[15], the data collected can then be compared to other data collected year on year. For example; before, during and after construction. Both upstream and downstream stop nets were deployed to avoid fish emigration and/or migration from the survey location. All fish caught were anaesthetised for processing, identified (species) and measured (fork length). Other non-salmonid species were recorded but not measured.

2.4.2 Semi-quantitative Assessments

Semi-quantitative surveys were achieved on survey location T1 via single-run timed fishing undertaken over a 7 minute period. Where timed surveys methods were used the catch per unit effort (CPUE) was calculated, this is achieved by dividing the catch by the effort used.

2.5 Fish Habitat Assessments

Fish habitat assessments were conducted alongside the electrofishing assessments. The methodology for habitat assessment employed for the fieldwork was conducted under a modified version of the Scottish Fisheries Coordination Centre (SFCC)[15] outlined in the Environment Agency document 'Restoration of Riverine Salmon Habitats: A guidance Manual'[5]. This focuses on the assessment of salmonid fish habitat and lamprey habitat, and the suitability of these respective areas to act as spawning areas. Predominant habitat was recorded within specific stretches, and the habitat classified employing the criteria in **Table 3**. The habitats outlined form definable sections of a wider spectrum of habitats commonly found in watercourses. Where spawning gravels were present and accessible, an assessment of their quality in terms of stability, compaction and siltation was made. In addition, the bankside structure and surrounding land use was also described where appropriate. Areas surveyed included 100m² sections with target notes recorded up to 250m upstream and downstream of the survey locations, given in **Table 2**.

[15] Scottish Fisheries Co-ordination Centre. (2007). *Habitat Surveys Training Course Manual*. pp. 1-64

Table 3. 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.
Lamprey spawning habitat	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt (but may contain some sand). Substrate size varies from gravels to pebbles.
Juvenile lamprey habitat	Optimal: Stable fine sediment or sand ≥15cm deep with low water velocity and the presence of organic detritus/plant material. Sub-optimal: Shallow sediment (<15cm deep), often patchy and interspersed among coarser substrates.
Eel habitat	Frequently burrow into mud and utilise cover from larger instream substrate and bankside crevices (e.g., gaps in bank modifications such as walls and log revetments).
Glides	Smooth laminar flow with little surface turbulence. Shallow glide ≤ 0.3m, deep glide > 0.3m.
Pools	No perceptible flow. Shallow pool ≤ 0.3m, deep pool > 0.3m.
Flow constriction	Where flows are accelerated between narrow banksides (usually combined with deep fast flows and bedrock substrates).
*Gravel (2-16mm), pebble (16-64mm), cobble (64-256mm), boulder (>256mm) ** If significant amounts of different habitat types were found to co-exist in the same section, these habitat classifications were adequately described. For example, in the case of salmonids, fry and parr habitat is classified as juvenile habitat. Where parr habitat is mentioned, this refers to habitat that has principally been identified as habitat more suited to parr than fry, however, habitually contains a lower quantity of fry habitat than habitat which is suited to both fry and parr. Salmonid definitions in **Table 4** are adapted from SFCC Habitat Manual[,5,,15].	

Predominant substrate and flow types was categorised according to SFCC[15] definitions outlined in **Table 4**.

Table 4.Substrate and flow type categorisation[15]

Substrate	Definition	Flow Types	Definitions
SA	Sand: Fine, inorganic particles, <2mm diameter, individual particles visible	DP	Deep Pool: > =30 cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
GR	Gravel: Inorganic particles 2-16 mm diameter	SP	Shallow Pool: < 30cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent
PE	Pebble: Inorganic particles 16-64 mm diameter	DG	Deep Glide: > =30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.

Substrate	Definition	Flow Types	Definitions
CO	Cobble: Inorganic particles 64-256mm diameter	SG	Shallow Glide: < 30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule is placed in the current, smooth surface appearance, water flow is silent.
BO	Boulder: Inorganic particles >256mm diameter	RU	Run: water flow fast, unbroken standing waves at surface; water flow is silent.
BE	Bedrock: Continuous Rock Surface	RI	Riffle: water flows fast, broken standing waves at surface; water flow is audible.
OB	Obstruction: Roots, wood, sheets of iron, barrels etc.	TO	Torrent: white water, chaotic and turbulent flow, water flow is noisy, difficult to distinguish substrate.

2.6 Analysis

2.6.1 Electrofishing Assessments

Densities of fish were calculated separately for fry (young of the year) and parr for both salmon and trout. Estimates of minimum density were calculated by dividing the number of fish caught by the area of habitat surveyed. Zippin corrections were applied where appropriate using the Removal Sampling II software (Pisces conservation)[16]. To provide a guide to the relative abundance of salmonid fish sampled during the survey, fish densities were classified per the SFCC classifications scheme Outer Hebrides region[17]. Godfrey's classification scheme is area based and calculated on a one-run approach, therefore classification for this survey is based only on the first pass of the multi-run approach. Grading from very poor through to excellent are given for abundance within each quintile range and absent for no fish caught.

For semi-quantitative surveys (7 minutes) catch per unit effort (CPUE) was calculated, this is achieved by dividing the catch by the effort used.

2.6.2 Fish Habitat Assessment

Fish habitat quality was undertaken both within (T3a, T5-T8, T10) and outwith (T1, T3b, C1) the site and at/adjacent to targeted water crossing sites (T5, T6). During the fish habitat survey for numerous species, observations and target notes were recorded to identify optimal habitat, including channel width; channel depth; flow type; substrate composition; instream and bankside cover; riparian canopy cover; fish spawning potential; riparian land uses; and associated limiting factors. From this, further analysis was undertaken, and evaluations were made for suitable spawning potential and fish habitat quality along the watercourse. Each survey location was then given a rating for fish habitat quality (**High**, **Good**, **Moderate**, **Low** or **Poor**) described in **Table 5**.

[16] Seaby, R.M.H. & Henderson, P.A. (2008) Population Estimation by Removal Sampling. Version 2.2.2.22, *Pisces Conservation*, Hampshire.

[17] Godfrey (2005) *Site Condition Monitoring of Atlantic Salmon SACs*. SFCC to Scottish Natural Heritage, Contract F02AC608.

Table 5. Fish habitat suitability grades

Grade	Conditions
High	All desirable habitat conditions are met.
Good	Most of desirable habitat requirements met with few adverse conditions present.
Moderate	Habitat displays a mixture of both desirable and adverse conditions.
Poor	Habitat primarily consists of adverse conditions with few desirable conditions present.
Low	Little/no desirable habitat conditions present.

Salmonid spawning potential was assessed via the SFCC Walkover Habitat Survey Protocol and Habitat Surveys Training Course Manual[15]. Survey locations were graded as having **Optimal**, **Sub-Optimal** or **Not Suitable** salmonid spawning potential. Spawning potential is considered optimal if an area greater than 10m^2 is present with clean and suitable substrate likely suitable to all salmonids. Spawning potential is considered sub-optimal if spawning area is <10m^2 with a mix of suitable and unsuitable substrate types. Not suitable spawning habitat contains no suitable spawning habitat. Additional assessment of spawning potential was taken to provide additional information on the categories assessed: substrate type, substrate compaction, river depth, flow type, and siltation[18]. Spawning habitat potential assessment criteria is shown in **Table 6**.

Table 6. Suitable Atlantic salmon and brown/Sea trout spawning habitat taken from SFCC[15] and Louhi et al. (2003)[18]

Species	Substrate	Substrate Compaction	Depth (cm)	Flow Type	Siltation
Salmon	Gravel, Pebble, Cobble	Uncompacted	20-50	Swift velocities	No siltation
Trout	Gravel, Pebble, Cobble	Uncompacted	15-45	Slower flow	No siltation

2.7 Limitations to Survey

During the fish habitat assessments (26.09.2023 – 28.09.2023) high amounts of filamentous algae were present in the lower catchment survey locations (T3b, T1) reducing visibility within the water course. Surveys which were conducted on 28.09.2023 were impacted by increased water levels due to rain from the previous evening, resulting in moderate-poor visibility, impact on catch efficiency and fluctuations in conductivity of the water resulting in variability in catch efficiency, though surveys still remain indicative and valid due to the number of salmonids captured.

3.0 Results

3.1 Desk Study

3.1.1 Watercourse Classification

Four classified watercourses were identified 2km from the proposed development within the SEPA (2022) Water Classification Hub.

SEPA[13] Water Classification Hub identified **Cleekhimin Burn (ID: 5276)** which flows through the River Tweed catchment of the Solway Tweed river basin district and runs up to the site is considered to be of 'Good' overall status, water quality and ecological status with high fish biological elements since 2012. The main stem is approximately 11.2km in length. The Cleekhimin Burn, splits into the **Soonhope Burn (5276)** and the **Whalplaw Burn (ID: 5277)** which both are considered to be of 'Good' ecological status. Jocks Burn which flows into the main stem of **Earnscleugh Water (ID:5275)** (13.4km length),

[18] Louhi, P., Mäki-Petäys, A. and Erkinaro, J. (2008). Spawning habitat of Atlantic Salmon and brown trout: general criteria and intergravel factors. *River Research and Applications*. 24(3). pp. 330-339

which is situated in the River Tweed catchment of the Solway Tweed river basin district, is considered to be of 'Good' overall status, water quality and ecological status with high fish biological elements since 2009.

All other watercourses within the site are unclassified.

3.1.2 Barriers to Migration

No barriers to migration were identified using Scotland's Environment Web[12] within any tributary within the site and 2km outside of the site line.

3.1.3 Protected Areas

NatureScot[14] identified one statutory conservation designation within a 2km buffer of the site; The Cleekhimin Burn falls within the River Tweed Special Area of Conservation (SAC) **(ID:8369)** which covers a total area of 3379.59 ha. The River Tweed SAC designation has relevance to fish (river lamprey *Lampetra fluviatilis*, brook lamprey *Lampetra planeri* and sea lamprey *Petromyzon marinus*) and Mammals (Eurasian otter *Lutra lutra*). All sites identified are outwith of the proposed site but have direct connection to Soonhope Burn and Whalplaw Burn.

3.2 Fully Quantitative Electrofishing Assessment

3.2.1 Fish Fauna

Table 7 presents fish fauna data for September 2023, minimum density classification per the SFCC classifications scheme[17], and population estimate using Zippin**Error! Bookmark not defined.** where possible. Please refer to **Appendix A, Table A-1** for raw data collected.

Table 7. Fish fauna results, classification and population estimates

Site Code	Fish Densities & Species	Length (mm)	Classification (*based on 1st passError! Bookmark not defined.*)	Population Estimate
T3a	Trout fry: 32 Trout Parr: 48 Salmon fry: 0 Salmon Parr: 1	Trout fry: 60 - 73 Trout Parr: 74 - 205 Salmon fry: n/a Salmon Parr: 89	Trout fry: Excellent Trout Parr: Excellent Salmon fry: n/a Salmon Parr: Very Poor	Trout fry: 36.31 Trout Parr: 89.16 Salmon fry: 0 Salmon Parr: 1.0
T3b	Trout fry: 41 Trout Parr: 46 Salmon fry: 0 Salmon Parr: 0	Trout fry: 48 - 73 Trout Parr: 74 - 24 Salmon fry: n/a Salmon Parr: n/a	Trout fry: Excellent Trout Parr: Excellent Salmon fry: n/a Salmon Parr: n/a	Trout fry: 42.99 Trout Parr: 51.48 Salmon fry: 0 Salmon Parr: 0
T5	Trout fry: 8 Trout Parr: 68 Salmon fry: 0 Salmon Parr: 0	Trout fry: 67 – 73 Trout Parr: 74 - 181 Salmon fry: n/a Salmon Parr: n/a	Trout fry: Good Trout Parr: Excellent Salmon fry: n/a Salmon Parr: n/a	Trout fry: 8.28 Trout Parr: 77.85 Salmon fry: 0 Salmon Parr: 0
T6	Trout fry: 49 Trout Parr: 48 Salmon fry: 0 Salmon Parr: 0	Trout fry: 58 - 80 Trout Parr: 83 - 200 Salmon fry: n/a Salmon Parr: n/a	Trout fry: Excellent Trout Parr: Excellent Salmon fry: n/a Salmon Parr: n/a	Trout fry: 53.68 Trout Parr: 54.47 Salmon fry: 0 Salmon Parr: 0
T7	Trout fry: 10 Trout Parr: 26 Salmon fry: 1 Salmon Parr: 3	Trout fry: 64 - 76 Trout Parr: 77 - 163 Salmon fry: 72 Salmon Parr: 80 - 86	Trout fry: Good Trout Parr: Excellent Salmon fry: Very Poor Salmon Parr: Poor	Trout fry: 11.72 Trout Parr: 26.73 Salmon fry: 1.0 Salmon Parr: 3.0
T8	Trout fry: 52 Trout Parr: 31	Trout fry: 57 - 75 Trout Parr: 76 - 140	Trout fry: Excellent Trout Parr: Excellent	Trout fry: 70.42 Trout Parr: 48.05

Site Code	Fish Densities & Species	Length (mm)	Classification (*based on 1st pass Error! Bookmark not defined.*)	Population Estimate
	Salmon fry: 12 Salmon Parr: 14	Salmon fry: 59 - 73 Salmon Parr: 74 - 91	Salmon fry: Excellent Salmon Parr: Excellent	Salmon fry: 38.29 Salmon Parr: 29.36
T10	Trout fry: 47 Trout Parr: 16 Salmon fry: 0 Salmon Parr: 0	Trout fry: 61 - 76 Trout Parr: 77 - 169 Salmon fry: n/a Salmon Parr: n/a	Trout fry: Excellent Trout Parr: Excellent Salmon fry: n/a Salmon Parr: n/a	Trout fry: 60.59 Trout Parr: 16.08 Salmon fry: 0 Salmon Parr: 0
C1	Trout fry: 127 Trout Parr: 26 Salmon fry: 3 Salmon Parr: 1	Trout fry: 52 - 77 Trout Parr: 80 - 164 Salmon fry: 66 - 76 Salmon Parr: 121	Trout fry: Excellent Trout Parr: Excellent Salmon fry: Poor Salmon Parr: Very Poor	Trout fry: 143.75 Trout Parr: 27 Salmon fry: 3.0 Salmon Parr: 1.0

3.2.1.1 Fish Fauna Summary

Site 1: T3a:

Both trout fry (0+) and trout parr (1++) were recorded in an excellent density. However salmon parr (1++) were recorded in very poor density (n=1.0) and salmon fry (0+) were absent from the survey location and no trout fry were recorded. No non-salmonid fish species were recorded. No redds were identified.

Site 2: T3b:

Juvenile trout both fry (0+) and parr (1++) were recorded in an excellent density. No salmon parr or fry were recorded. No redds were identified. Eleven stone loach (*Barbatula barbatula*) were recorded.

Site 3: T5:

Trout fry (0+) were recorded in a good density together with an excellent density of trout parr (1++). No salmon parr or fry were recorded. No redds were identified. One stone loach was recorded.

Site 4: T6

Both trout fry (0+) and parr (1++) were recorded in an excellent density. Salmon fry (0+) and parr (1++) were absent from the survey location. No non-salmonid fish species were recorded. No redds were identified.

Site 5: T7:

Trout fry (0+) recorded were of a good density alongside parr (1++) which were of an excellent density. Both salmon fry (0+) and parr (1++) were present at the survey location and recorded as poor, very poor, respectively. No non-salmonid fish species were recorded. No redds were identified.

Site 6: T8:

Both salmon and trout fry (0+) and parr (1++) were all recorded as being of excellent density. No redds were identified. Fifteen stone loach were recorded across the multiple runs.

Site 7: T10:

Both trout fry and parr were recorded in an excellent density. No salmon parr or fry were recorded. No non-salmonid fish species were recorded. No redds were identified.

Site 8: C1:

Trout fry (0+) and parr (1++) were recorded as excellent density. Both salmon fry (0+) and parr (1++) were present at the survey location and recorded as poor, very poor, respectively. No redds were identified. Two juvenile river lamprey (*Lampetra fluviatilis*) were recorded, as well as three 3 spined sticklebacks (*Gasterosteus aculeatus*).

3.3 Semi-quantitative Electrofishing Assessment

3.3.1 CPUE

Survey location T1 was electrofished for 7 minutes and had a total abundance of 20 trout and 23 salmon. CPUE for trout equalled 2.8 and 3.2 for salmon. Fourteen minnows (*Phoxinus phoxinus*), five 3 spined sticklebacks and one stone loach were recorded during the timed electrofishing.

3.4 Fish Habitat Assessment

Fish habitat quality (FHQ) and salmonid spawning potential (SSP) was undertaken both within (T3a, T5-T8, T10) and outwith (T1, T3b, C1) the site and at/adjacent to targeted water crossing survey locations (T5, T6). Results for both FHQ and SSP surveys are presented in **Table 8**.

3.4.1 Fish Habitat Quality

FHQ ranged from: Good (T3a, T3b, T6, T7, T10, C1); and Moderate (T1, T5, T8). No habitat surveyed in September 2023 was identified at the time to be deemed High, Poor or Low habitat quality.

3.4.2 Salmonid Spawning Potential

SSP ranged from: Optimal (T3b, T6, T7, C1); and Sub-Optimal (T1, T3a, T5, T8, T10). No habitat from September 2023 survey was deemed Not Suitable for potential salmonid spawning habitat.

Target notes were collected on site describing watercourse features within the 250 m from the survey location point. Refer to Appendix C, Table C.1 for target notes and locations.

Table 8. Fish habitat assessment results.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Potential	Reach Description and Limiting Factors
T1	Moderate	Survey location outside of site: Wet width was constant throughout the survey location at 7m, and bed width ranged from 6-6.4 m. Flow type was dominated by both DG (70%) and SG (30%). Watercourse depth ranged from 11- 30 cm but with water predominately being 21-30 cm deep (60%). Substrate was varied with SA (5%), GR (10%), PE (35%), CO (30%) and B0 (5%) present throughout providing moderate instream cover. Banks were undercut on both sides (LB=10%/ RB=5%) through fish cover was limited (LB=40%, RB=30%). The flow and substrate layout is particularly suitable for Juvenile trout. No lamprey habitat was found. Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with continuous cattle use and potential pollution caused by road traffic.	Sub- Optimal	Substrate was sub-optimal for salmonid spawning with no areas of continuous GR/PE stretches. Fast flowing currents (run and riffle) were not identified limiting flow which could facilitate egg development. Filamentous algae in large quantities was present throughout the site.
T3a	Good	Survey location outside of site: Wet width ranged from 2.6-3.1m. Flow type was dominated by faster moving RU (75%) with areas of RI (10%) and DG (15%). Watercourse depth ranged from <11->50cm, but with water depth predominately being 11-20 cm (60%). Substrate was varied with GR (10%), PE (35%), CO (50%) and BO (5%) present throughout, providing good instream	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Potential	Reach Description and Limiting Factors
		cover. Fish cover was poor on both banks with 10% undercutting present and 90% bare. The flow types and substrates made this watercourse good for salmonids (parr, 1++), though lack of coverage in the margins might reduce fry densities within survey location. Land use is predominately rough pasture and road.		
T3b	Good	Survey location inside site: Wet width ranged from 3.5-4.6m throughout the survey location. Flow type was dominated by faster moving RU (75%) with RI (15%). Watercourse depth ranged from <10-40 cm but with water predominately being 21-30 cm deep (75%). Substrate was varied with GR (5%), PE (30%), CO (55%) and B0 (10%) providing good instream cover. Banks were undercut on only the right bank (30%). The flow and substrate layout is particularly suitable for various salmonid life stages, though fry may be limited due to the lack of undercutting across the margins. limited lamprey habitat was found. Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with continuous cattle use and potential pollution caused by road traffic.	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.
T5	Moderate	Survey location inside site: Wet width ranged from 3.7 – 4.2 m. Flow type was dominated by slower moving SG (70%) with RI (5%) and RU (25%). Watercourse depth ranged from <10-30 cm but with water predominately being 21-30 cm deep (55%). Substrate was varied with GR (45%), PE (30%), CO (20%) and BO (5%) present throughout, providing moderate instream cover. The flow and substrate type would make this survey location suitable for trout parr (1++) but it is unlikely salmon would be found within the survey location. Additionally, erosion of the banks was also noted both in the survey lcoation and within the target note range. Land use is predominately moorland/heath and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic. Additionally a potential barrier to migrating salmonids was found at NT 53573 54342 (Appendix B Plate 11).	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. However, salmonids lack of fast flowing water could reduce egg development.
T6	Good	Survey location inside site: Wet width ranged from 3.2-4.1m. Flow type was dominated by faster moving RU (70%) and RI (20%) sequences with DP (10%) pockets. Watercourse depth ranged from 11-50 cm but with water predominately being 31-40 cm deep (40%). Substrate was varied with GR (10%), PE (35%), CO (45%), BO (10%)	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Potential	Reach Description and Limiting Factors
		present throughout with some SA (5%) and BE (5%) also present, providing moderate instream cover. Banks were predominately bare (90-100%) reducing the suitability of the survey location to facilitate salmonid fry (0+). The flow and substrate types provide good habitat quality for a range of salmonid life stages particularly trout. Additionally, erosion of the banks was also noted both in the survey survey location and within the target note range. Land use is predominately rough pasture and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic. Additionally a potential barrier to migrating salmonids was found at NT 53573 54342 (Appendix B Plate 11).		
T7	Good	Survey location inside site: Wet width ranged from 3.25-5m. Flow type was dominated by faster moving RU (65%) with pockets of RI (5%), SG (20%) and DG (20%) areas. Watercourse depth ranged from <10-40 cm but with water predominately being 21-30 cm deep (80%). Substrate was varied with GR (10%), PE (35%), CO (50%), BO (5%) present throughout. Banks were undercut on both sides (LB=15%/ RB=50%), though both banks were bare (50-70%) reducing the suitability of the survey location to facilitate salmonid fry (0+). The flow, substrate and undercutting of the banks provide good habitat quality for a range of salmonid life stages. Additionally, erosion of the banks was also noted within the target note range. Land use is predominately rough pasture and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic.	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.
T8	Moderate	Survey location inside site: Wet width ranged from 5.2 – 6m throughout the survey location. Flow type was dominated by faster moving RU (75%) with RI (25%) also present throughout. Watercourse depth ranged from 11-40 cm but with water predominately being 21 – 30 cm deep (70%). Substrate was varied with GR (10%), PE (10%), CO (65%) and BO (15%) present throughout providing good instream cover. Banks were undercut only on the left bank (25%). The flow and substrate layout and undercutting is particularly moderately suitable for various salmonid life stages. Limited lamprey habitat was found. Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Potential	Reach Description and Limiting Factors
		continuous cattle use and potential pollution caused by road traffic across the ford.		
T10	Good	Survey location inside site: Wet width ranged from 1.5 – 3 m throughout the survey location. Flow type was dominated by faster moving RU (40%), RI (25%) with DP (15%) and DG (20%) present throughout. Watercourse depth ranged from 11->50 cm but with water predominately being 31-40 cm deep (45%). Substrate was varied with GR (25%), PE (30%), CO (45%), BO (15%) and BE (5%) present throughout providing good instream cover. Banks were undercut on both sides (LB=15%, RB=25%), though both banks were bare (40-60%). The flow, substrate and coverage from banks provide good habitat for a range of salmonid life stages, particularly for trout. Limited lamprey habitat was found. Land use is predominately moorland/heath and road use. Limiting factors within this section are potential pollution caused by road traffic and low flow reducing ability to pass through the culvert for migrating fish (Appendix C, Picture 3 & 4).	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the survey location which could facilitate egg development. Additionally, steep gradients throughout the lower water course levels could reduce migrating abilities to pass the culvert.
C1	Good	Survey location outside of site: Wet width ranged from 3 – 3.8 m throughout the survey location. Flow type was dominated by faster moving RU (45%) with RI (35%) and SG (20%) present throughout. Watercourse depth ranged from <10-40 cm but with water predominately being 21 – 30 cm deep (70%). Substrate was varied with GR (25%), PE (30%) and CO (40%) with small patches of SA (5%) present throughout providing moderate instream cover. Banks were undercut on the right bank (10%). The flow, substrate and coverage from banks provide good habitat for a range of salmonid life stages. Patches of lamprey habitat was found. Land use is predominately road and rough pasture.	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout. Lamprey habitat in sand pockets were found.

4.0 Discussion

Fish Fauna and Habitat Quality Survey Summary

Both Atlantic salmon and brown/ sea trout were present across survey locations within the site. Atlantic salmon parr (1++) were present on the Whalplaw Burn, though an in river barrier/ obstacle (2m height) was identified during the September 2023 survey (Appendix B Plate 11) which was deemed impassable under low water conditions due to the rock formation which is most likely why salmon were not present within the most upper reaches of the Whalplaw Burn at survey locations T5 and T6 (within the site).

Salmon fry were not present within the Whalplaw Burn at the time of survey; although, this could be due to the lack of habitat which fry are commonly found in (i.e., uncut banks). This does not confirm

absence as salmon fry may be present within the Whalplaw Burn elsewhere. Atlantic salmon fry (0+) were present at survey locations only within Soonhope Burn inside of the site (T7, T8) at locations where undercut banks were more prominent and faster waters were observed. Trout fry (0+) and parr (1++) were present across all electrofished survey locations, though it is mostly likely trout found within the Whalplaw Burn above T3a inside the site are brown resident trout and unlikely to migrate due the barrier observed. Trout were found at survey location T10 where migrating is likely to be impeded by the culvert identified, thus, all trout found within this survey location are most likely to remain as brown resident trout.

No suitable eel habitat was found across all surveyed locations, as undercut banks were very shallow, and there was lack of rock formation providing suitable hiding substrate. Lamprey habitat was found at the control survey location (C1) where sand substrate in large patches was identified to have residing river lamprey and where fast water flow was present.

Based on the substrate and flow regimes found during the September 2023 electrofishing surveys, four survey locations were deemed to be of optimal SSP (T3b, T6, T7, C1); although, no redds were identified during the 2023 surveys. Various trout parr (1++) captured during the electrofishing displayed lateral spawning coloration and enlarged lower abdomens (most likely females). No redds were identified during the 2023 surveys.

5.0 Conclusion and Recommendations

Instream barriers faced by salmonids and lamprey were not identified with a review of SEW[12]; although two barriers were observed during survey, one located within the Whalplaw Burn (2m height rock formation) and one within Jocks Burn (Culvert) where species segregation was found to occur pre barrier (Appendix B Plate 9 & 11). The results provide a baseline to indicate the potential impact of the proposed development on these freshwater systems within the Tweed Catchment.

In conclusion, increased traffic disturbance of substrate throughout the valley could increase boulder movement and further barricade segments within the valley to further increase species segregation throughout Whalplaw Burn and reduce species spawning throughout the site.

The potential impacts, in the absence of mitigation, that the proposed development could have on surrounding fish populations are well documented. The potential for fish species and their habitats to be affected by the proposed development mainly occurs during the construction and decommissioning phases.

During the construction phase potential impacts, in the absence of strict adherence to mitigation, include siltation from ground disturbance, accelerated or exacerbated erosion, hydrological changes, pollution, and the blocking or hindering of the upstream/downstream migration of fish. During the operational phase, in the absence of mitigation, potential impacts include the effects of poor road drainage, accelerated levels of erosion, fish access, and the maintenance of silt traps and road crossings. Potential risks during the decommissioning phase are broadly similar to those in the construction phase. These potential effects could all impact on the surrounding fish populations by causing direct mortality of juveniles and adults, direct habitat loss (damage of instream and riparian habitats), direct and indirect habitat severance (emanating from fish avoidance behaviour and blocking of migration routes to spawning beds resulting in unused habitat), direct and indirect habitat degradation (for example, resulting from pollution impacts) and indirect effects via changes in food availability (from the above pressures).

Results from surveys conducted in September 2023 indicate that Atlantic salmon were absent across all surveyed sites above T3a within Whalplaw Burn. No previous electrofishing data has been conducted on these systems providing essential data for the Tweed Catchment stocks. Additionally, salmonid reduction over time may be attributed to the various well documented factors[19] including (but not limited to):

[19] http://www.nasco.int/pdf/reports_other/Salmon_at_sea.pdf (Accessed August 2023)

- Biological characteristics (e.g., size) of salmon smolts;
- Physical factors in fresh water (water flow and temperature);
- Freshwater contaminants;
- Predation; and
- Salmon aquaculture.

Trout populations from the September 2023 survey, ranged from Good to Excellent and were present at all of the survey locations, providing baseline data for Tweed Catchment stocks where historical data regarding trout within the catchment is limited.

Based on the results of this report it is recommended that:

- The proposed development has been designed to minimise the number of watercourse crossing points and that it is sufficiently distant (>50m) from watercourses.

- Pollution prevention measures will require to be employed during the construction process and a suitable water quality programme established to ensure that the construction phase does not impact on the fish habitats.

- Construction and post-construction fish fauna monitoring programme will require to be carried out utilising the same nine (control site included) fish fauna sites as part of an ongoing assessment of potential impacts which may occur due to the proposed development. The suggested monitoring schedules are as follows: Fish fauna surveys annually during construction (summer/early autumn) and post-construction Year 1 (summer/early autumn) and Year 2 (summer/early autumn).

- Macroinvertebrate sampling is recommended to be conducted at all nine survey locations. The purpose of this macroinvertebrate data is to provide a longer-term water quality monitoring that can be compared and monitored over the duration of the proposed development and to demonstrate biodiversity recovery post construction. Baseline ecological condition for watercourses will be used as an indicator of overall watercourse health over time.

- A pre-construction, construction and post-construction water quality monitoring programme is carried out as part of an ongoing assessment of potential impacts, which may occur due to the proposed development. This will help to protect the aquatic assemblage throughout the proposed development and in the long term, highlighting where impacts may be occurring, and mitigation can be designed to address accordingly. It will also provide evidence of the scale of impact on the surrounding watercourses from any pollution incidents which may or may not be directly related to the proposed development.

- A suitably qualified / experienced Environmental Clerk of Works (ECoW) should be on site, periodically, for the construction phase of the proposed development.

- Design the proposed development to avoid potentially increasing erosion or vibrations that may result in further erosion and explore opportunities to enhance riparian corridor (e.g., wet woodland planting).

Figures

Figure 8.5.1: Site Location

Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

Renewable Energy Systems (RES)

SLR Project No.: 405.064862.00001

30 October 2023

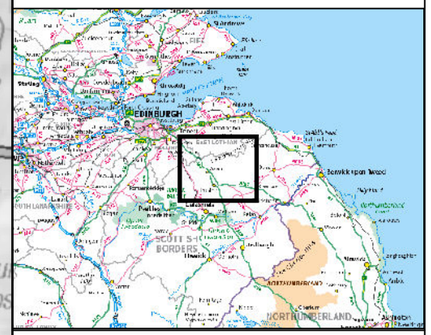
340000 350000 360000 370000

660000 650000

LEGEND

Site Boundary

N



res

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LONGCROFT WIND FARM

LONGCROFT FISHERY REPORT

SITE LOCATION MAP

FIGURE 8.5.1

Scale	Date
1:100,000 @ A3	OCTOBER 2023

405.064862.00001.0043.0 Site Location Map

Appendix A Raw Data

Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

Renewable Energy Systems (RES)

SLR Project No.: 405.064862.00001

30 October 2023

Table A1: Electrofishing results, Zippin estimates[17], site dimensions, fish density and minimum estimate.

Survey Location	Age Class/ Species	2023 Actual Catch	Lower 95% confidence interval	Upper 95% confidence interval	Site Length (m)	Avg. width (m)	Area Covered m² (Min Est.)	Minimum Est.
T1	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	7 12 15 8	n/a n/a n/a n/a	n/a n/a n/a n/a	33	6.2	204.6	n/a n/a n/a n/a
T3a	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	32 48 0 1	32 48 n/a 1	44.57 60.9 n/a 1	34	3	102	36.31 89.16 0 1.0
T3b	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	41 46 0 0	41 46 n/a n/a	47.1 60.35 n/a n/a	26	4	104	42.99 51.48 0 0
T5	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	8 68 0 0	8 68 n/a n/a	9.74 90.68 n/a n/a	25	4	100	8.28 77.85 0 0
T6	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	49 48 0 0	49 48 n/a n/a	61.27 64.58 n/a n/a	40	3.1	124	53.68 54.47 0 0
T7	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	10 26 1 3	10 26 1 3	17.48 28.95 1 3	40	2.6	104	11.72 26.73 1.0 3.0
T8	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	52 32 12 14	52 31 12 14	98.36 84.65 214.31 93.07	25	4.1	102.5	70.42 48.05 38.29 29.36
T10	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	47 16 0 0	47 16 n/a n/a	81.79 16.67 n/a n/a	35	3	105	60.59 16.08 0 0
C1	Trout fry: Trout Parr: Salmon fry: Salmon Parr:	127 26 3 1	127.62 26 3 1	159.87 29.77 3 1	33	3.3	108.9	143.75 27 3.0 1.0

Appendix B Site Photos

Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

Renewable Energy Systems (RES)

SLR Project No.: 405.064862.00001

30 October 2023

Plate 1: T1, Semi-quantitative survey location, wide channel with shallow glide.

Plate 2. T3a.

Plate 3. T3b.

Plate 4. T5:

Plate 5 T6.

Plate 6: T7.

Plate 7: T8.

Plate 8: T10

Plate 9: T10: Culvert

Plate 10: C1

Plate 11: Potential Barrier above between T5 and T3a.

Plate 12. Cleekhimin Burn: Non-barrier downstream.

Appendix C Target Notes

Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

Renewable Energy Systems (RES)

SLR Project No.: 405.064862.00001

30 October 2023

Table C1: Target Notes.

Survey Location	Target Note No.	Easting	Northing	Description
T5	1	354625	656028	Bank erosion 
T7	2	353409	655988	Left and right bank erosion 
N/A	3	355009	655787	Watercourse dry
N/A	4	354993	655279	Watercourse dry

Survey Location	Target Note No.	Easting	Northing	Description
T10	5	356509	356270	Culvert, could be impassable under certain flow conditions.
T10	6	356511	656399	Bankface erosion 

Annex A: Fish Habitat Assessment

Longcroft Wind Farm

Technical Appendix 8.5: Fish Habitat Assessment and Fully Quantitative Electrofishing Surveys

Renewable Energy Systems (RES)

SLR Project No.: 405.064862.00001

30 October 2023

Longcroft Wind Farm

Technical Appendix 8.5 Annex A: Fish Habitat Assessment

Renewable Energy Systems (RES)

Prepared by:

SLR Consulting Limited

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SLR Project No.: 405.064.862.00001

19 October 2023

Revision: V01

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
01	19 October 2023	Amy Green	Nicola Tyrrell	Nicola Tyrrell
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

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Executive Summary

SLR Consulting ('SLR') was appointed by Renewable Energy Systems Ltd (RES) ('the Client') to undertake survey work relating to fish habitat quality (FHQ) (including salmonid spawning suitability (SSS)) to determine the potential presence of fish species at the proposed wind farm ('the proposed development').

The proposed development is based on a layout of 19 turbines with a tip height of 220m, associated turbine foundations, crane pads, access tracks, control building and substation, energy storage/ battery compound and anemometry mast. A range of temporary construction phase features will also be developed, including borrow bits, construction compounds and laydown areas.

Fish habitat quality ranged from: Good (T1, T3b); Moderate (T3a, T4, T6, T7, T8, T10, T11); Poor (T2, T5, T12); and Low (T9). No habitat identified at the time were deemed to be High. Optimal (T3b, T6, T7); Sub-Optimal (T1, T3a, T4, T5, T8, T10, T11) and Not Suitable (T2, T9, T12). No large areas surveys regarding substrate composition were deemed Optimal/ Sub-Optimal habitat for juvenile lamprey, though undercutting of banks has the potential to support European eel.

Based on the results of this report it is recommended that:

- The proposed development has been designed to minimise the number of watercourse crossing points and that site infrastructure is sufficiently distant (>50m for all infrastructure except site tracks) from watercourses.
- Pollution prevention measures should be employed during the construction process and a suitable water quality programme established to ensure that the construction phase does not impact on the fish habitats.
- Electrofishing surveys are conducted for survey locations rated as Good or Moderate for fish habitat quality to establish baseline data on the abundance, density, and fish composition with the proposed development. This can be used to inform of any protected species within the area (e.g., Atlantic salmon) and the potential impact the proposed development has on fish abundance, density and composition during pre-construction, construction and post-construction.
- Macroinvertebrate sampling is recommended to be conducted at all survey locations where a crossing point is proposed or where turbine/infrastructure construction is within 100 m of a watercourse. The purpose of this macroinvertebrate data is to provide a longer-term water quality monitoring that can be compared and monitored over the duration of the project and to demonstrate biodiversity recovery post-construction. Baseline ecological condition for watercourses will be used as an indicator of overall watercourse health over time.
- A pre-construction, construction and post-construction water quality monitoring programme is carried out as part of an ongoing assessment of potential impacts, which may occur due to the proposed development. This will help to protect the proposed development in the long-term and provide evidence of scale of impact on the surrounding watercourses from any pollution incidents which may or may not be directly related to the proposed development.
- A suitably qualified / experienced Aquatic Ecological Clerk of Works (ECoW) should be on site, periodically, for the construction phase of the proposed development.

Table of Contents

Tables in Text

Appendices

Acronyms and Abbreviations

RES	Renewable Energy Systems Ltd
FHS	Fish Habitat Survey
FHQ	Fish Habitat Quality
SSS	Salmonid Spawning Suitability

1.0 Introduction

1.1 Background

SLR Consulting ('SLR') was appointed by Renewable Energy Systems Ltd (RES) ('the Client') to undertake survey work relating to fish habitat quality (FHQ) (including salmonid spawning suitability (SSS)) to determine the potential presence of fish species at the proposed wind farm ('the proposed development'). The 'site' refers to all land within the red line boundary, as displayed in **Figure 1.**

The Client intends to submit an application to the Scottish Government Energy Consents Unit under Section 36 of the Electricity Act 1989 to develop a renewable electricity generating station, including a wind farm and battery storage site, at Longcroft, located within the Scottish Borders.

The proposed development is based on a layout of 19 turbines with a tip height of 220m, associated turbine foundations, crane pads, access tracks, control building and substation, energy storage/ battery compound and anemometry mast. A range of temporary construction phase features will also be developed, including borrow bits, construction compounds and laydown areas.

The proposed development is located approximately 6 km northeast of Lauder and approximate distance 34 km southeast of Edinburgh. The proposed development entrance is located within central Ordnance Survey (OS) grid reference NT528537, located within the Tweed catchment.

Survey locations are based on the potential impacted watercourses identified in **Figure 1.**

1.2 Study Objectives

The objectives of this report were to:

- Undertake fish habitat assessments within the site area where there is potential for impact on the aquatic environment during construction and operation to identify potential important ecological features;
- To put watercourses into context to that of the wider riverine environment;
- Identify potential spawning areas for salmonids (Atlantic salmon (*Salmo salar*) / sea trout/ brown trout (*Salmo trutta*) and lamprey (*Lampetra fluviatilis/ Lampetra planeri*), European eel (*Anguilla anguilla*); and
- To provide recommendations for future surveys.

2.0 Methodology

2.1 Project Personnel

Table 1 details all personnel involved in aquatic habitat surveying of the proposed development.

Table 1. Project Personnel

Personnel	Role
Amy Green	Project Ecologist
Sophie McPeake	Assistant Ecologist

2.2 Desk Study

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

- Longcroft Wind Farm Desk Study Report (see Technical Appendix 8.1).

- Bing Maps[1]– to obtain aerial imagery to inform field surveys and access suitability to survey along steep slope;
- Ordnance Survey Map[2] – to obtain maps for the area covered by the proposed development and to inform survey location and gradient limitations;
- Scotland's Environment Web[3] – to obtain data on obstacles to fish migration on affected watercourses and to determine expected species within the surrounding location (~2 km area boundary);
- Scottish Environment Protection Agency (SEPA)[4]– to review information on the SEPA Water Classification Hub regarding the classification status of watercourses with potential to be affected by the proposed development; and
- NatureScot[5] – to perform a search to identify survey locations with relevant qualifying interests within 2 km of the site.

2.3 Survey Locations

Table 2 provides a list of all survey locations and justification. Please note a full walkover was conducted along Cleekhimin Burn at the request of the client.

Table 2. Survey Locations for Longcroft Fish Habitat Assessments

Waterbody	Survey Location	Upstream	Downstream	Justification for Surveying
Cleekhimin Burn	T1	NT527535	NT527535	Most downstream watercourse, outwith the site.
Aller's Burn	T2	NT530536	NT529537	Adjacent to proposed. site access track. Outside site.
Whalplaw Burn	T3.a	NT537545	NT537545	Potential of full extent run off from proposed development. Outside site.
	T3.b	NT529538	NT529538	Potential of full extent run off from proposed development. Outside site.
	T4	NT543552	NT542551	Potential of full extent run off from borrow pit and from T4.
	T5	NT546560	NT546560	Potential of full extent run off from borrow pit and from T4, T15 and T16. Water crossing point.
	T6	NT549565	NT548565	Potential of full extent run off from borrow pit and from T15 and T16. Water crossing point.

[1] Bing Maps. (2022). Search. [Online] Available at: https://www.bing.com/maps/

[2] Ordnance Survey Maps. (2023). Maps. [Online] Available at: https://shop.ordnancesurvey.co.uk/maps/ [Accessed 24/04/2023]

[3] Scotland's Environment Web. (2022). Search Scotland's Environment Map. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed 24/04/2023]

[4] Scottish Environment Protection Agency. (2022). SEPA Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed 24/04/2023]

[5] NatureScot. (2022). Map Search. [Online] Available at: https://sitelink.nature.scot/map [Accessed 24/04/2023]

Waterbody	Survey Location	Upstream	Downstream	Justification for Surveying
Soonhope Burn	T7	NT533559	NT532559	Potential of full extent run off from T17 and T18
	T8	NT529552	NT529552	Potential of full extent run off from T19. Full scale pollution impact areas for Soonhope Burn.
Hope Burn	T9	NT528545	NT528545	Control area within the site.
Jocks Burn	T10	NT565563	NT565562	Potential of full extent run off from borrow pit and T6, T5 and T3.
	T11	NT565571	NT565571	Potential of full extent run off from T8, T9 and T10.
	T12	NT567578	NT567577	Potential of full extent run off from T12, T11. Adjacent to substation and battery storage compound.

2.4 Riverine Assessments

Survey locations were determined prior to visiting the proposed development during the desk study. Watercourses visible at the 1:25,000 scale (OS map) within the site were considered for survey where there was a potential for ecological impacts from the proposed development.

Fieldwork for all survey locations was conducted over 2 days from 31st July 2023 to 1st August 2023 by two experienced surveyors (Table 1). Weather conditions on the day of sampling were clear with rain spouts with an ambient temperature of 13°C.

The methodology for habitat assessment employed for the fieldwork was conducted under a modified version of the Scottish Fisheries Coordination Centre (SFCC)[6] outlined in the Environment Agency document 'Restoration of Riverine Salmon Habitats: A guidance Manual'[7] . This focuses on the assessment of salmonid fish habitat and lamprey habitat, and the suitability of these respective areas to act as spawning areas. Predominant habitat was recorded within specific stretches, and the habitat classified employing the criteria in **Table 3**. The habitats outlined form definable sections of a wider spectrum of habitats commonly found in watercourses.

Where spawning gravels were present and accessible, an assessment of their quality in terms of stability, compaction and siltation was made. In addition, the bankside structure and surrounding land use was also described where appropriate. Areas surveyed included 100m^2 sections with target notes recorded up to 250 m upstream and downstream of the survey locations, given in **Table 2**. In survey locations where the watercourses ceased to have definable features and/or were determined unsuitable to support any fish species the survey was not continued upstream of this point.

Table 3. 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.

[6] Scottish Fisheries Co-ordination Centre. (2007). Habitat Surveys Training Course Manual. pp. 1-64

[7] Hendry, K. and Cragg-Hine, D. (1997). Restoration of Riverine Salmon Habitats: A Guidance Manual. pp. 1-250.

Habitat Type	Classification
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.
Lamprey spawning habitat	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt (but may contain some sand). Substrate size varies from gravels to pebbles
Juvenile lamprey habitat	Optimal: Stable fine sediment or sand ≥15cm deep with low water velocity and the presence of organic detritus/plant material. Sub-optimal: Shallow sediment (<15cm deep), often patchy and interspersed among coarser substrates.
Eel habitat	Frequently burrow into mud and utilise cover from larger instream substrate and bankside crevices (e.g., gaps in bank modifications such as walls and log revetments).
Glides	Smooth laminar flow with little surface turbulence. Shallow glide ≤ 0.3m, deep glide > 0.3m.
Pools	No perceptible flow. Shallow pool ≤ 0.3m, deep pool > 0.3m.
Flow constriction	Where flows are accelerated between narrow banksides (usually combined with deep fast flows and bedrock substrates).
*Gravel (2-16mm), pebble (16-64mm), cobble (64-256mm), boulder (>256mm) ** If significant amounts of different habitat types were found to co-exist in the same section, these habitat classifications were adequately described. For example, in the case of salmonids, fry and parr habitat is classified as juvenile habitat. Where parr habitat is mentioned, this refers to habitat that has principally been identified as habitat more suited to parr than fry, however, habitually contains a lower quantity of fry habitat than habitat which is suited to both fry and parr. Salmonid definitions in Table 4 are adapted from SFCC Habitat Manual[Error! Bookmark not defined.,Error! Bookmark not defined.,8].	

Predominant substrate and flow types was categorised according to SFCC[6] definitions outlined in **Table 4**.

Table 4. Substrate and Flow Type Categorisation.

Substrate	Definition	Flow Types	Definitions
SA	sand: Fine, inorganic particles, <2mm diameter, individual particles visible.	DP	Deep Pool: > =30 cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
GR	Gravel: Inorganic particles 2-16 mm diameter.	SP	Shallow Pool: < 30cm deep, water flow slow, eddying, no waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
PE	Pebble: Inorganic particles 16-64 mm diameter.	DG	Deep Glide: > =30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule placed in the current, smooth surface appearance, water flow is silent.
CO	Cobble: Inorganic particles 64-256mm diameter.	SG	Shallow Glide: < 30 cm deep, water flow moderate/fast; waves form behind a 2-3 cm wide rule is placed in the current, smooth surface appearance, water flow is silent.

[8] Maitland, P. S. 2003. Ecology of the river, brook and sea lamprey. English Nature, Conserving Natura 2000 Rivers Ecology Series 5, Peterborough

Substrate	Definition	Flow Types	Definitions
BO	Boulder: Inorganic particles >256mm diameter.	RU	Run: water flow fast, unbroken standing waves at surface; water flow is silent.
BE	Bedrock: Continuous Rock Surface.	RI	Riffle: water flows fast, broken standing waves at surface; water flow is audible.
OB	Obstruction: Roots, wood, sheets of iron, barrels etc.	TO	Torrent: white water, chaotic and turbulent flow, water flow is noisy, difficult to distinguish substrate.

2.4.1 Analysis

During the fish habitat survey for numerous species, observations and target notes were recorded to identify optimal habitat, including channel width; channel depth; flow type; substrate composition; instream and bankside cover; riparian canopy cover; fish spawning potential; riparian land uses; and associated limiting factors. From this, further analysis was undertaken, and evaluations were made for suitable spawning potential and fish habitat quality along the watercourse. Each survey location was then given a rating for fish habitat quality (**High**, **Good**, **Moderate**, **Poor** or **Low**) described in **Table 5**.

Table 5. Fish Habitat Suitability Grades.

Grade	Conditions
High	All desirable habitat conditions are met.
Good	Most of desirable habitat requirements met with few adverse conditions present.
Moderate	Habitat displays a mixture of both desirable and adverse conditions.
Poor	Habitat primarily consists of adverse conditions with few desirable conditions present.
Low	Little/no desirable habitat conditions present.

Salmonid spawning potential was assessed via the SFCC Walkover Habitat Survey Protocol and Habitat Surveys Training Course Manual[6]. Survey locations were graded as having **High**, **Optimal**, **Sub-Optimal** or **Not Suitable** salmonid spawning potential. Spawning potential is considered optimal if an area greater than 10m^2 is present with clean and suitable substrate likely suitable to all salmonids. Spawning potential is considered sub-optimal if spawning area is <10m^2 with a mix of suitable and unsuitable substrate types. Not suitable spawning habitat contains no suitable spawning habitat. Additional assessment of spawning potential was taken to provide additional information on the categories assessed: substrate type, substrate compaction, river depth, flow type, and siltation[9]. Spawning habitat potential assessment criteria is shown in **Table 6**.

Table 6. Suitable Salmon and Trout Spawning Habitat taken from SFCC (2007) and Louhi et al. (2003).

Species	Substrate	Substrate compaction	Depth (cm)	Flow Type	Siltation
Salmon	Gravel, Pebble, Cobble	Uncompacted	20-50	Swift velocities	No siltation
Trout	Gravel, Pebble, Cobble	Uncompacted	15-45	Slower flow	No siltation

2.5 Limitations to Survey

Watercourses situated on the easterly hills which flow into Soonhope Burn were investigated but no waterflow was present at NT534560 (Appendix B, Photograph 7). At location NT532557, waterflow was found; however, due to safety concerns regarding the steep gradient, staff were not permitted to investigate the watercourse. Watercourses flowing into Earnscleugh Water which were below T1

[9] Louhi, P., Mäki-Petäys, A. and Erkinaro, J. (2008). Spawning habitat of Atlantic Salmon and brown trout: general criteria and intergravel factors. River Research and Applications. 24(3). pp. 330-339

(Trow Burn), T2 (Hogs Burn), T3, T6 (Green Burn), T8 (Jocks Burn) (**Figure 8.5.1**) could not be investigated due to no land access, margins of the watercourses within the site ceased to exist.

3.0 Results

3.1 Desk Study

3.1.1 Watercourse Classification

4 classified watercourses were identified 2km from the proposed development within the SEPA (2022) Water Classification Hub.

SEPA[10] Water Classification Hub identified **Cleekhimin Burn (ID: 5276)** which runs through the River Tweed catchment of the Solway Tweed river basin district which runs up to the site is considered to be of 'Good' overall status, water quality and ecological status with high fish biological elements since 2012. The main stem is approximately 11.2 kilometres in length. The Cleekhimin Burn, splits into the **Soonhope Burn (5276)** and the **Whalplaw Burn (ID: 5277)** which both are considered to be of good ecological status. Jocks Burn which flows into the main stem of **Earnscleugh Water (ID:5275)** (13.4 km length), which resides in the River Tweed catchment of the Solway Tweed river basin district, is considered to be of 'Good' overall status, water quality and ecological status with high fish biological elements since 2009.

All other watercourses within the site are unclassified.

3.1.2 Barriers to Migration

No Barriers to Migration were identified by Scotland's Environmental Web[11].

3.1.3 Protected Areas

NatureScot[5] identified 1 conservation designations within a 2 km buffer of the proposed development site; The Cleekhimin Burn falls within the River Tweed Special Area of Conservation (SAC) (ID:8369) which covers a total area of 3379.59 ha. The River Tweed SAC designation has relevance to fish (Atlantic salmon, Brooke Lamprey and River Lamprey) and Mammals (Otter). All sites identified are outwith of the site but have direct connection to Soonhope Burn and Whalplaw Burn.

3.2 Fish Habitat Quality Surveys

Results of the fish habitat quality surveys are presented in **Appendix A, Table 7** and have been illustrated on **Figure 1.**

Fish habitat quality ranged from: Good (T1, T3b); Moderate (T3a, T4, T6, T7, T8, T10, T11); Poor (T2, T5, T12); and Low (T9). No habitat identified at the time were deemed to be High.

3.3 Salmonid Spawning Potential

Results of the salmonid spawning potential surveys are presented in **Appendix A, Table 7** and have been illustrated on **Figure 2.**

Salmonid spawning potential ranged from: Optimal (T3b, T6, T7); Sub-Optimal (T1, T3a, T4, T5, T8, T10, T11) and Not Suitable (T2, T9, T12).

[10] Scottish Environment Protection Agency. (2022). SEPA Water Classification Hub. [Online] Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [Accessed 02/08/2023].

[11] Scotland's Environment Web. (2022). Search Scotland's Environment Map. [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed 02/08/2023].

Target notes were collected on site describing watercourse features within the 250 m from the survey location point. Refer to **Appendix C, Table 8** for target notes and locations.

4.0 Discussion

4.1 Fish Habitat Quality

Survey locations with Good FHQ were located outside of the site at the lower reaches of the Cleekhimin Burn. Moderate FHQ was found throughout the proposed development boundary and were mostly found again within the lower reaches of the Soonhope Burn and Whalplaw Burn. Poor sites were characteristically narrow, with slow moving and deep water or where water was extremely shallow with limited suitable substrates. One site was deemed low where it was predominately bedrock, with shallow bank faces and limited canopy cover deeming it to be of low fish habitat quality throughout the site.

No important ecological features (IEF) were identified during the survey, however substrates and flow within sites deemed good to moderate would support Atlantic Salmon and sea/brown trout therefore it is recommended for electrofishing at these survey locations.

Some areas could potentially support eel populations where undercutting was pronounced, however there was limited mud substrate and instream cover which may illustrate lack of eel presence. It is recommended that sites where undercutting was present are further assessed using electrofishing methods.

4.2 Salmonid Spawning Suitability

Survey locations deemed both Good and Moderate were spread throughout the proposed development and outwith the site. Sites deemed not suitable were in areas where it was predominately bedrock and water flow was light and/or limited. Additionally, sites deemed sub-optimal were predominantly found throughout the Soonhope Burn and Whalplaw Burn.

The culvert located at T10 could pose a problem to migrating salmonids when under limited flow regimes, especially during dry months. There is potential for salmonids to migrate past the barrier, and it is recommended electrofishing T10 in particular to assess if salmonids and eels could be present.

The barrier at the entrance to the Cleekhimin Burn was posed not to be a barrier to migration due to the height and flow was still possible under various flow regimes.

No spawning redds were identified during the August 2023 survey.

4.3 Lamprey Suitability

Small areas of sand and gravel were observed across various survey locations, distributed amongst interstitial spaces between substrate types. No survey location was deemed to have large densities of optimal and sub-optimal juvenile lamprey habitat[7]. It is recommended that electrofishing of all sites deemed Good to Moderate is undertaking to address if lamprey in both spawning and juvenile stages are present.

5.0 Recommendations

Based on the results of this report it is recommended that:

- Pollution prevention measures should be employed during the construction process and a suitable water quality programme established to ensure that the construction phase does not impact on the fish habitats.
- Electrofishing surveys are conducted for survey locations rated as Good or Moderate for fish habitat quality to establish baseline data on the abundance, density, and fish composition within the site. This can be used to inform of any protected species within the area (e.g., Atlantic salmon) and the potential impact the proposed development has on fish

abundance, density and composition during pre-construction, construction, post-construction.

- Macroinvertebrate sampling is recommended to be conducted at all survey locations where a crossing point is proposed or where turbine construction is within 100 m of a watercourse. The purpose of this macroinvertebrate data is to provide a longer-term water quality monitoring that can be compared and monitored over the duration of the project and to demonstrate biodiversity recovery post construction. Baseline ecological condition for watercourses will be used as an indicator of overall watercourse health over time.
- A pre-construction, construction and post-construction water quality monitoring programme is carried out as part of an ongoing assessment of potential impacts, which may occur due to the proposed development. This will help to protect the proposed development in the long term and provide evidence of scale of impact on the surrounding watercourses from any pollution incidents which may or may not be directly related to the proposed development.
- A suitably qualified / experienced Aquatic Ecological Clerk of Works (ECoW) should be on site, periodically, for the construction phase of the proposed development.

348000 350000 352000 354000 356000 358000 360000

660000 658000 656000 654000

T12 T11 T6 T10 T5 T7 T8 T4 T9 T3a T3b T1 T2

N

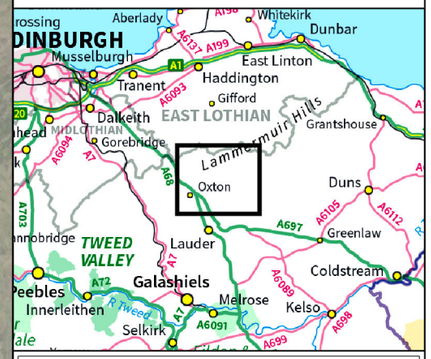
0 1 2
Kilometers

LEGEND

- Site Boundary
- Site Boundary 2km Buffer
- Proposed Turbine Layout
- Proposed Tracks
- Proposed Turning Head
- Proposed Temporary Construction Compound
- Proposed Temporary Concrete Batching Plant
- Proposed Substation Compound
- Proposed Site Entrance
- Proposed Hardstanding
- Proposed Battery Storage Compound
- Proposed Borrow Pit Search Area
- Proposed Watercourse Crossing

Fish Habitat Quality

- Good
- Low
- Moderate
- Poor



res power for good

SLR

LONGCROFT WIND FARM

FISH SURVEYS

FISH HABITAT QUALITY

FIGURE 8.5.1

Scale 1:40,000 @ A3

Date OCTOBER 2023

405.064862.00001.0025.0 Fish Habitat Quality

348000 350000 352000 354000 356000 358000 360000

660000 658000 656000 654000

T12 T11 T10 T6 T5 T7 T8 T4 T9 T3a T3b T1 T2

N

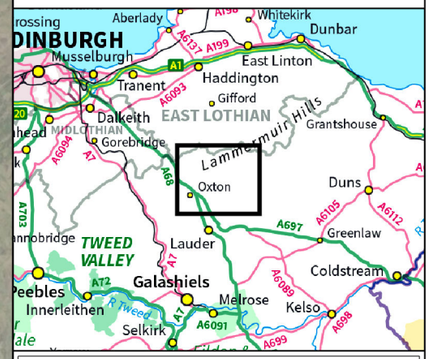
0 1 2
Kilometers

LEGEND

- Site Boundary
- Site Boundary 2km Buffer
- Proposed Turbine Layout
- Proposed Tracks
- Proposed Turning Head
- Temporary Construction Compound
- Temporary Concrete Batching Plant
- Proposed Substation Compound
- Proposed Site Entrance
- Proposed Hardstanding
- Proposed Borrow Pit Search Area
- Proposed Battery Storage Compound
- Watercourse Crossing

Salmonid Spawning Suitability

- Not Suitable
- Optimal
- Sub-Optimal



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LONGCROFT WIND FARM

FISH SURVEYS

SALMONID SPAWNING SUITABILITY

FIGURE 8.5.2

Scale	Date
1:40,000 @ A3	OCTOBER 2023

405.064862.00001.0026.0 Salmoid Spawning Suitability

Appendix A Fish Habitat Results

Table 7.Fish Habitat Quality and Salmonid Spawning Suitability Survey Results

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T1	Good	Wet width was constant throughout the site at 7m and bed width ranged from 7-7.5m. Flow type was dominated by faster moving RU (65%) with RI (25%)/ DG (5%) and SM (5%) also present throughout. Watercourse depth ranged from <10->50 cm but with water predominately being 21-30 cm deep (40%). Substrate was varied with GR (5%)/ PE (10%)/ CO (60%)/ BO (25%) present throughout providing good instream cover. No smaller substrate types were identified. Banks were undercut on both sides (LB=40%/ RB=80%) with additional instream draping. The flow and substrate layout is particularly suitable for trout and salmon parr. No lamprey habitat was found. Additionally, sparse instream vegetation was recorded which provides further instream cover for fish (willow herb, forget me not). Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with continuous cattle use and potential pollution caused by road traffic. Note: at NT520523 on Cleekhimin Burn, a potential impassable barrier may present a problem to migrating fish when water conditions are low.	Sub- Optimal	Substrate was Sub-optimal for salmonid spawning with no areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T2	Poor	Wet width ranged from 0.3 – 0.6 m. Flow type was dominated by faster moving SG (85%) with small sections of RI (10%) and RI (5%). Watercourse depth Was constantly low at <10 cm, though there were areas that could not be visually inspected due to foliage. Substrate was varied with GR (25%), PE (45%) CO (15%), BO (15%) present throughout. Cover was provided by tall grasses and shrubs throughout the survey site, though no undercutting was observed, though banksides were bare (100%). The flow types and substrates made this watercourse unsuitable for salmonids at a range of life stages. Land use is predominately rough pasture and road use. Limiting factors within this section are lack of flow and narrow passages during low flow. Refer to Appendix C Photograph 14.	Not suitable	Substrate was Sub-optimal for salmonid spawning with no large areas of continuous GR/PE stretches. However low flow and narrow passages limit the site and deeming it not suitable. Refer to Appendix C Photograph 14.
T3a	Moderate	Wet width ranged from 3-3.5m. Flow type was dominated by slower moving SG (45%) with areas of RU (20%)/ RI (10%) sequences with SM (5%) and DP (20%) also present in small areas. Watercourse depth ranged from <10->50cm, but with water predominately being 11-20 cm (30%) and 21-30cm (45%) deep. Substrate was varied with GR (15%), PE (45%), CO (20%), SA (10%) and BO (10%) present throughout, providing poor instream cover. Fish cover was poor on both banks with 15% undercutting present and 95% bare. The flow types and substrates made this watercourse moderate for trout fry. Land use is predominately rough pasture and moorland/heath.	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development. Small patches of SA present could facilitate juvenile lamprey habitat, though depth in this area is a limitation to spawning suitability.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T3b	Good	Wet width ranged from 2.5-4m throughout the site. Flow type was dominated by faster moving RU (80%) with RI (10%)/ SG (10%) also present throughout. Watercourse depth ranged from <10-50 cm but with water predominately being 21-30 cm deep (40%). Substrate was varied with GR (10%)/ PE (40%)/ CO (35%)/ BO (10%) and SA (5%) present throughout providing moderate instream cover. Banks were undercut on both sides (LB=20%/ RB=60%) with additional instream draping (LB=10%). The flow and substrate layout is particularly suitable for various salmonid life stages. limited lamprey habitat was found. Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with continuous cattle use and potential pollution caused by road traffic.	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.
T4	Moderate	Wet width ranged from 2-2.5m throughout the site. Flow type was dominated by slow moving SG (90%) with small sequence of RU (5%) and RI (5%) also present. Watercourse depth ranged from 11-30cm but with water predominately being 21-30 cm deep (75%). Substrate was varied with GR (15%)/ PE (60%)/ CO (10%)/ BO (10%) and SA (5%) present throughout providing poor instream cover. Banks were undercut on both sides (LB=50%/ RB=25%), though both banks were very bare (50-90%). The flow and substrate layout is particularly suitable trout life stages. limited lamprey habitat was found. Land use is predominately rough pasture and moorland/heath. Limiting factors within this section are erosion of the banks and potential reduction in water levels.	Sub-optimal	Substrate was Sub-optimal for trout spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development. Small patches of SA present could facilitate juvenile lamprey habitat, though depth in this area is a limitation to spawning suitability.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T5	Poor	Wet width ranged from 3-5 m. Flow type was dominated by slower moving SG (70%) with RI (5%)/ RU (20%) sequences with DG (5%). Watercourse depth ranged from <10-40 cm but with water predominately being 21-30 cm deep (75%). Substrate was varied with GR (25%)/ PE (20%)/ CO (30%)/ BO (20%) present throughout with some SA (5%) also present, providing moderate instream cover. Banks were bare at 100% making this survey location of poor quality. Additionally, erosion of the banks was also noted both in the survey site and within the target note range. Land use is predominately moorland/heath and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic.	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. However, salmonids lack of fast flowing water could reduce egg development.
T6	Moderate	Wet width ranged from 3.2-4m. Flow type was dominated by faster moving RU (45%) and RI (30%) sequences with DG (15%) pockets. Watercourse depth ranged from 11-50 cm but with water predominately being 41-50 cm deep (40%). Substrate was varied with GR (10%)/ PE (30%)/ CO (40%)/ BO (10%) present throughout with some SA (10%) also present, providing moderate instream cover. Banks were undercut on both sides (LB=10%/ RB=65%), though both banks were very bare (90%). The flow, substrate and undercutting of the banks provide moderate habitat quality for a range of salmonid life stages. Additionally, erosion of the banks was also noted both in the survey site and within the target note range. Land use is predominately rough pasture and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic (Appendix C, Photograph 8).	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T7	Moderate	Wet width ranged from 3.25-5m. Flow type was dominated by faster moving RU (60%) and RI (30%) sequences with pockets of SP (5%) and SG (5%) areas. Watercourse depth ranged from <10-50 cm but with water predominately being 21-30 cm deep (80%). Substrate was varied with GR (5%)/ PE (30%)/ CO (50%)/ BO (10%) present throughout with some SA (5%) also present. Banks were undercut on both sides (LB=15%/ RB=50%), though both banks were bare (50-70%). The flow, substrate and undercutting of the banks provide moderate habitat quality for a range of salmonid life stages. Additionally, erosion of the banks was also noted within the target note range. Land use is predominately rough pasture and road use across the ford. Limiting factors within this section are low water levels during summer months and potential pollution caused by road traffic.	Optimal	Substrates and flow types provide optimal spawning conditions for salmon and trout.
T8	Moderate	Wet width ranged from 3.5-7m throughout the site. Flow type was dominated by faster moving RU (80%) with RI (15%)/ SG (5%) also present throughout. Watercourse depth ranged from <10-40 cm but with water predominately being 11-21 cm deep (60%). Substrate was varied with GR (15%)/ PE (20%)/ CO (30%)/ BO (30%) and BE (5%) present throughout providing good instream cover. Banks were undercut on both sides (10%), though both banks were bare (90%). The flow and substrate layout and undercutting is particularly moderately suitable for various salmonid life stages. limited lamprey habitat was found. Land use is predominately rough pasture and road use. Limiting factors within this section are erosion of the banks with continuous cattle use and potential pollution caused by road traffic across the ford.	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. However, lack of water depth in this site may present a problem for spawning if water levels reduce.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T9	Low	Wet width ranged from 0.2-0.3m throughout the site. Flow type was dominated by RU (100%). Watercourse was shallow at <10 (100%). Substrate was dominated by BE (40%), PE (10%) and SA (50%). Banks were 100% bare. The flow, depth and substrate layout make this site low habitat quality for salmonids and lamprey. Land use is predominately rough pasture and road use. Limiting factors within this section are gradient of the watercourse and potential pollution caused by road traffic.	Not suitable	Substrate was not suitable for salmonid spawning with no large areas of continuous GR/PE stretches. Low flow and narrow passages limit the site suitability
T10	Moderate	Wet width ranged from 1.6-2m throughout the site. Flow type was dominated by faster moving RU (50%), RI (30%) with DP (5%) and DG (15%) present throughout. Watercourse depth ranged from 11-50 cm but with water predominately being 31-40 cm deep (45%). Substrate was varied with GR (10%), PE (30%), CO (50%) and BO (10%) present throughout providing moderate instream cover. Banks were undercut on both sides (LB=15%, RB=5%), though both banks were bare (50-70%). The flow, substrate and coverage from banks provide moderate habitat for a range of salmonid life stages. Limited lamprey habitat was found. Land use is predominately moorland/heath and road use. Limiting factors within this section are potential pollution caused by road traffic and low flow reducing ability to pass through the culvert for migrating fish (Appendix C, Photograph 3 & 4).	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development. Though flow and narrow passage could present an issue. Additionally, steep gradients throughout the lower water course levels could reduce migrating abilities.

Survey Location	Fish Habitat Quality	Reach Description and Limiting Factors	Salmonid Spawning Suitability	Reach Description and Limiting Factors
T11	Moderate	Wet width ranged from 0.8-1.75m throughout the site. Flow type was dominated by faster moving RU (50%), RI (30%) with DG (20%) present throughout. Watercourse depth ranged from <10-50 cm but with water predominately being 21-30 cm deep (40%). Substrate was varied with GR (15%), PE (30%), CO (40%), BO (10%) and small patches of SA (5%) present throughout providing moderate instream cover. Banks were undercut on both sides (LB=20%, RB=5%), though both banks were bare (60-90%). The flow, substrate and coverage from banks provide moderate habitat for a range of salmonid life stages. Limited lamprey habitat was found. Land use is predominately moorland/heath and rough pasture. Limiting factors within this section are low water levels when ambient temperature increases.	Sub-optimal	Substrate was Sub-optimal for salmonid spawning with small areas of continuous GR/PE stretches. Continuous flow was noted throughout the site which could facilitate egg development. Though flow and narrow passage could present an issue. Additionally, steep gradients throughout the lower water course levels could reduce migrating abilities.
T12	Poor	Wet width ranged from 0.45-1.8m throughout the site. Flow type was dominated by faster moving RU (50%) with RI (5%) and DP (15%) present throughout. Watercourse depth ranged from 11->50 cm but with water predominately being 41-50 cm deep (50%). Substrate was varied with GR (20%), PE (10%), CO (60%), BO (5%) and small patches of SA (5%) present throughout providing poor instream cover. Banks were undercut on both sides (LB=10%, RB=80%), though both banks were bare (40%). The flow, substrate and coverage from banks provide poor habitat for a range of salmonid life stages. Limited lamprey habitat was found. Land use is predominately moorland/heath and rough pasture. Limiting factors within this section are low water levels when ambient temperature increases.	Not Suitable	Substrate was not suitable for salmonid spawning with no large areas of continuous GR/PE stretches. Low flow and narrow passages limit the site suitability

Appendix B Site Photographs

Photograph 1. T11 survey location: bank erosion, very peated waters, high build-up of large boulders and cobbles within the survey location.

Photograph 2. T12 survey location: extremely deep pool, narrows significantly post pool. Predominately still marginal, deep pool.

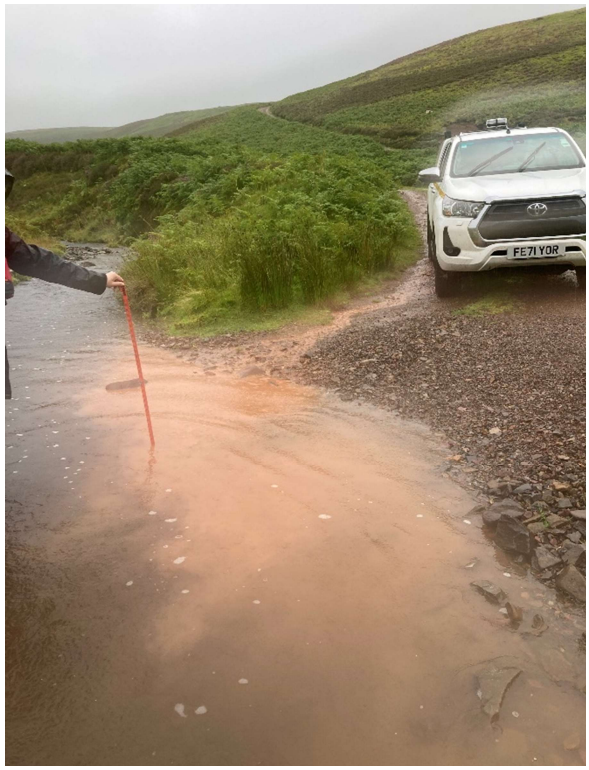
Photograph 3. T10 survey location: Culvert, potential barrier under certain flow conditions.

Photograph 4. T10 survey location: culvert exit, potential barrier under certain flow conditions.

Photograph 5. T10 survey location: good instream cover, with multiple run and riffle sequencing.

Photograph 6. T10 survey location: target note, bank erosion upstream

Photograph 7. T4 turbine, not watercourse located.



Photograph 8. T6 survey location: Run off from road into water course. Potential baseline pollution impact.

Photograph 9. T5 survey location: Bank erosion

Photograph 10. T6 survey location: Bank erosion

Photograph 11. T7 survey location: bank erosion

Photograph 12. Watercourse within Soonhope Burn which has no flow

Photograph 13. T8 survey location: potential flow course under high flow activity

Photograph 14. T2 survey location: Not suitable for salmonids, extremely overgrown, shallow and narrow.

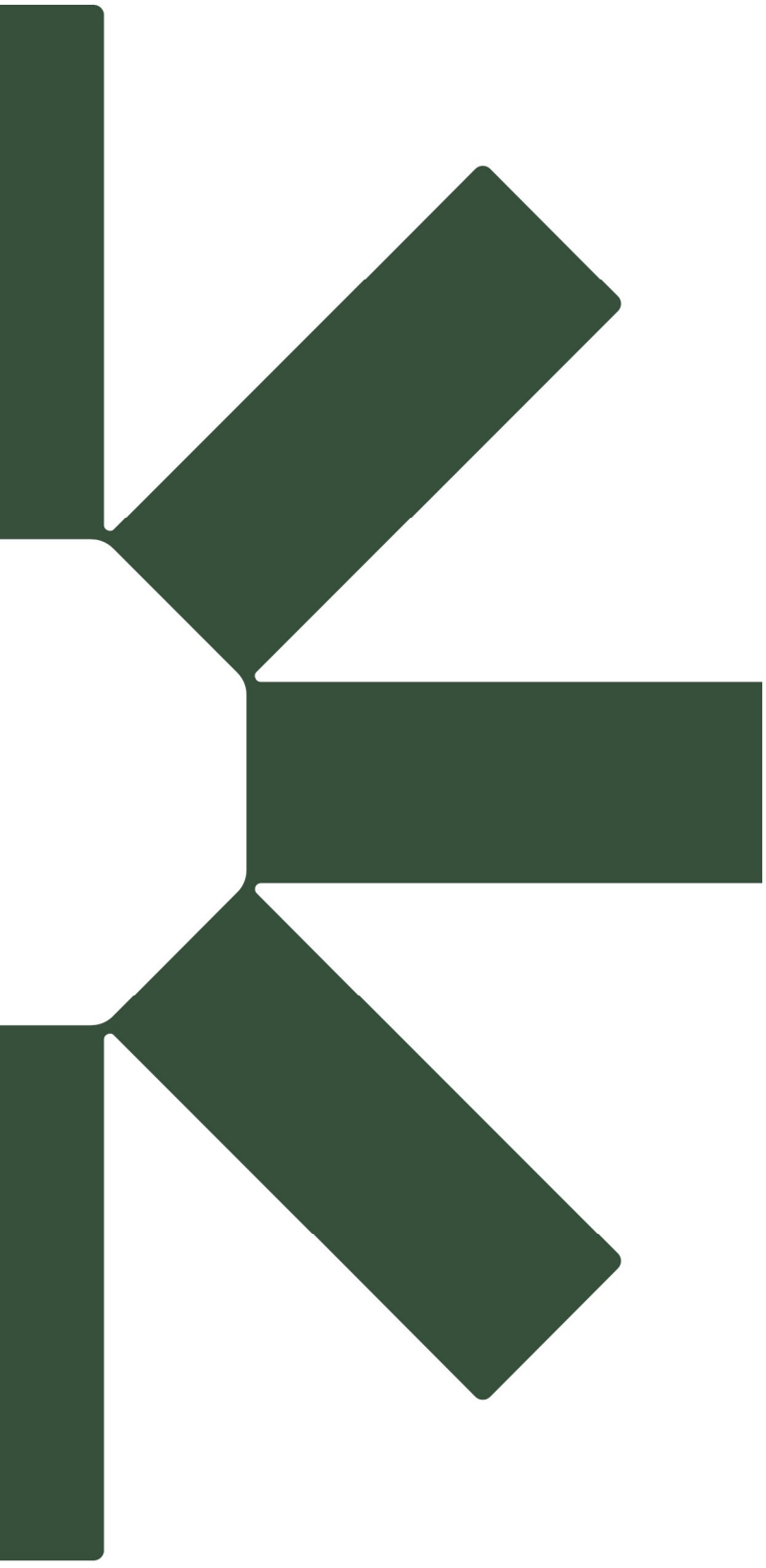
Photograph 15. Cleekhimin Burn bank erosion.

Photograph 16. Cleekhimin Burn bank erosion.

Appendix C Target Notes

Table 8.Target Notes for Fish Habitat Surveys

Survey Location	Target Note No.	Easting	Northing	Description
T5	1	354625	656028	Bank erosion (Photograph 9)
T7	2	353409	655988	Left and right bank erosion (Photograph 11)
N/A	3	355009	655787	Watercourse dry
N/A	4	354993	655279	Watercourse dry
T10	5	356509	356270	Culvert, could be impassable under certain flow conditions.
T10	6	356511	656399	Bankface erosion
T12	7	356711	657834	Stagnant water, unsuitable for fish both from habitat quality and spawning suitability (see Photograph 2).



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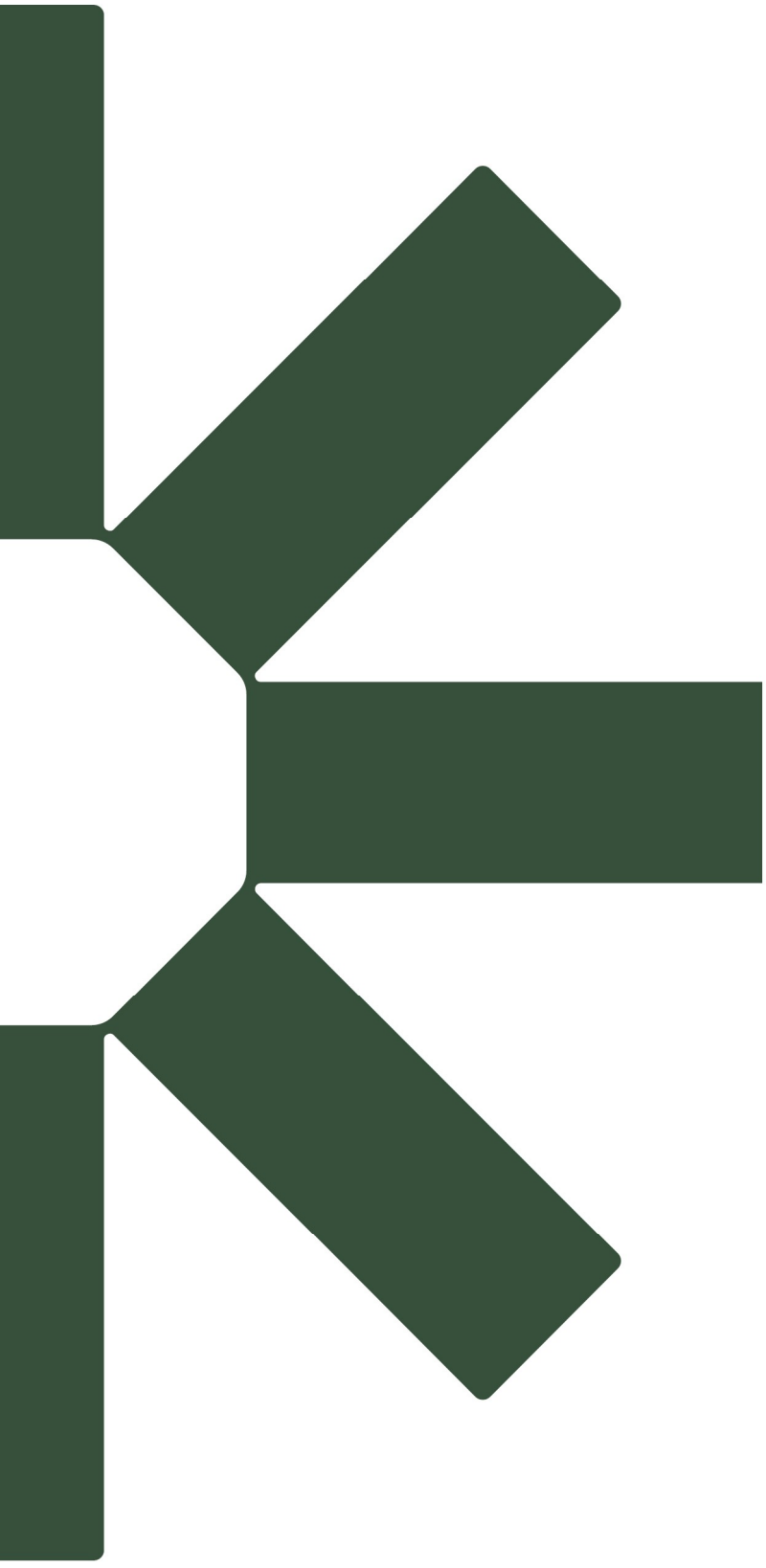

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