Document	**Fishtek Responses to NatureScot Technical Queries**
Project	Glen Earrach Energy – Dochfour Weir Fish Passage
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This standalone technical note provides responses to NatureScot's clarification points of 23 April 2026 in relation to fish passage and construction-phase fish passage continuity at Dochfour Weir. It should be read in conjunction with the March 2026 River Moriston SAC submission pack, including the Fishtek Optioneering Summary Rev 004, the Temporary Fish Passage Technical Note and associated drawings.

The technical fish passage responses have been prepared by Fishtek. Certain applicant confirmations and supporting evidence, including the photographic tailwater scaling material and commitments relating to construction sequencing, monitoring installation, commissioning and detailed control-system development, have been provided by Glen Earrach Energy (The Applicant). Where Applicant-provided material is included, Fishtek has considered it for the purpose of responding to NatureScot's clarification points, but the provenance of that material remains as stated in the relevant section or appendix.

This note addresses the outstanding clarification points directly and does not replace the submitted documents, except where a specific clarification or supplementary explanation is provided.

1. Fishtek Optioneering Summary Rev 004, §2.3.2 — Downstream water level / fish pass design

The proposed fish pass design is based on typical downstream water level derived from the design drawings of the previous temporary fish pass operated during the 2017-18 canal repairs. It is not clear how those water levels were derived at the time, nor whether the fish passage option proposed now would still be feasible should the values shown on the 2017-18 drawings prove to be different to current conditions. We therefore advise you undertake sensitivity analysis to show the implications of deviations from the estimate of downstream level on the design of the fish pass that would still meet the requirements in Table A1. If this analysis shows that additional sections would be required in the fish pass, are there any physical constraints to the overall footprint of the pass that would render it unfeasible? Please also provide some empirical evidence of a downstream water level immediately below the weir from which to base the sensitivity analysis.

Level validation

The water level taken from the 2017-18 temporary fish pass drawing was based on a measured water level obtained during summer flows. Whilst additional empirically measured water levels are not available at this stage, indicative photographic scaling and sensitivity analysis has been undertaken as part of the hydraulic development of the proposed fish pass facilities to provide confidence in the measured level.

The Applicant has provided an indicative photographic tailwater scaling pack, using surveyed reference points on the existing SSE sluice structure (Appendix 1). Under low loch/low river conditions on 6 February 2026, the downstream tailwater is visually estimated at approximately 14.4–14.5 mAOD. Under a higher loch-level condition on 14 November 2025, with the SSE sluice not open, the same reference point indicates a higher tailwater level of approximately 14.8–14.9 mAOD.

These observations support the conclusion that the 14.40 mAOD level used in the previous temporary fish pass drawing remains a reasonable and conservative lower-bound design assumption for the present concept-stage. The photographic scaling exercise should be treated as indicative observational evidence rather than a substitute for continuous instrumented water-level monitoring.

Sensitivity analysis

The photographic scaling material appended to this note as Appendix 1 was prepared by the Applicant and has been reviewed by Fishtek for the purpose of informing the sensitivity assessment. The hydraulic sensitivity analysis and interpretation of fish pass implications are Fishtek's technical assessment.

To consider the potential design implications of minimum downstream water levels deviating from the previously measured level, a sensitivity envelope of 14.00 mAOD – 15.00 mAOD has been adopted. The measured level of 14.40 mAOD sits broadly centrally within this band. The potential consequence of a change in downstream water level towards the upper and lower bounds of this envelope, respectively, are summarised as follows:

- Under an increase in the assumed downstream water level to 15.00 mAOD, the maximum head drop across the weir that would need to be accommodated by the proposed fish pass would reduce by 0.60 m from 2.10 m to 1.50 m. The current fish pass design has maximum head drops of 0.21 m per slot across a total of 10 slots. Therefore under this upper bound the head drop per slot would reduce by 0.06 m to an average of 0.15 m. This reduced head drop is half of the maximum typically permitted for passage of salmon (Fishtek Optioneering Summary - Appendix 1) and would therefore represent an overall improvement to passability compared to the current measured level. *Note: as a by-product of the reduction in head drop per slot under this scenario, the total fish pass flow would reduce marginally. Therefore, if this scenario were to materialise the hydraulic design of the fish pass would be updated to maintain the same total fish pass discharge outlined in the optioneering document. This would be achieved by widening each slot marginally, setting the invert (base) of each slot lower to achieve a greater depth, or a combination of the two.*
- Under a reduction in the assumed downstream water level to 14.00 mAOD, the maximum head drop across the weir that would need to be accommodated by the proposed fish pass would increase by 0.40 m from 2.10 m to 2.50 m. The total head drop per slot would therefore increase by 0.04 m to 0.25 m. The head drop remains beneath the recommended upper limit of 0.30 m for passage of salmon (Fishtek Optioneering Summary - Appendix 1) and therefore the fish pass would remain usable for salmon across the full design window.

It is apparent from the above scenarios that the proposed fish pass design has a significant degree of hydraulic flexibility in relation to i) how variations in downstream water level can be accommodated by the type of fish pass that is proposed and ii) the degree of hydraulic contingency within the design compared to maximum recommended head drop limits for salmon. The existing design could accommodate a total maximum head drop of 3.00 m (0.30 m head per slot) whilst maintaining adherence to best practice design guidance before additional pools are required, equating to a downstream water level of 13.50 mAOD. This level is 0.90 m lower than the water level measured previously and significantly below the levels derived through the photographic validation in the appendices.

In the highly unlikely event that measured downstream water levels are shown to fall below 13.50 mAOD under low flow conditions (i.e. almost a full metre lower than the previously recorded level), there is scope to revise the proposed fish pass design to accommodate the additional head loss. This would involve the addition of up to two extra pools/slots through a 180° change in direction at the upstream end. This arrangement would function effectively up to a maximum head drop of 3.60 m (equating to a minimum downstream level of 12.90 mAOD) whilst remaining within guidance for upstream salmon passage.

Based on the current concept layout and the available footprint at the preferred fish pass location, Fishtek considers that the addition of up to two further pools / slots could be accommodated without rendering the fish pass unfeasible. This would require local refinement of the fish pass alignment, including the 180° change in direction noted above, but no physical constraint has been identified at this stage that would prevent such an arrangement being developed if future downstream water-level monitoring demonstrated that it was required. This will be confirmed during outline design once final surveyed downstream water-level data are available.

It should be noted that additional robust downstream water level data will be collected as part of a future phase of work to feed into the final hydraulic design of the proposed fish passage facilities. Data collection will involve installation of downstream water level loggers at the site to collect data across a representative range of low and high flow conditions. The outputs from this will provide a level-flow relationship for each monitored location, tied into metres above ordnance datum (mAOD). The resulting data will provide the required level of certainty to finalise the hydraulic design of the fish pass.

2. Fishtek Optioneering Summary, Section 6 — Kelt passage

NatureScot's question:

Please clarify, with evidence, whether the proposed smolt passes will be capable of providing suitable passage for kelts, including at low loch levels during the kelt/smolt migration season.

The proposed smolt passes are expected to provide appropriate downstream passage routes for kelts in their own right. The adjustable weir crest and proposed upstream fish pass would provide additional downstream route availability, but the suitability of the smolt passes for kelt passage does not depend on those additional routes. This conclusion is supported by the following design elements and observations from scientific literature:

- Salmon kelts are predominantly surface orientated during downstream migration. For example, Babin et al. (2021) [1] recorded salmon kelts occupying the surface layer of the water column for 96 % of the period of migration through reservoirs. The inlets to the smolt

[1] Babin, A. B., Ndong, M., Haralampides, K., Peake, S., Jones, R., Curry, R. A., & Linnansaari, T. (2021). Overwintering and migration behaviour of post-spawned Atlantic salmon Salmo salar in a large hydropower-regulated river and reservoir. *Journal of Fish Biology*, *99*(3), 856-874.

passes, alongside the passage routes via the weir crest and upstream fish pass, are all surface orientated which aligns with the known migration behaviour of salmon kelts.

- Compared to salmon smolts, kelts are considered somewhat less sensitive to accelerating flow paths and display less aversive behaviour when encountering accelerating flow. For example, Simmons et al. (2024)[2] recorded salmon kelts readily migrating downstream of a hydropower dam via a spillway gate which was subject to pronounced acceleration of flow. Therefore it is considered that the controlled flow acceleration into the smolt passes, which has been designed to accommodate the higher hydraulic sensitivity of smolts, will also provide appropriate hydraulic conditions for kelt passage.
- Several studies have demonstrated a measurable and significant reduction in time taken for kelts to negotiate barriers to migration following implementation of additional downstream passage routes, akin to what is proposed at Dochfour. Nyqvist et al. (2017)[3] assessed the mean time taken for kelts to pass downstream of a hydropower dam before and after the implementation of bywash optimisations and the construction of a new nature-like fish pass. The median time taken for kelts to pass the dam reduced from 220 min (interquartile range: 18 min – 10 days) to 34 minutes (interquartile range: 20 min – 202 min). Similarly, Wertheimer (2007)[4] recorded a reduction in kelt migration delay following construction of a new bypass channel at the Bonneville Dam. These studies demonstrate the principle that it is possible to achieve measurable reductions to kelt migration delay at existing barriers to migration.
- During low loch levels the adjustable element at the inlet to the smolt passes will maintain a focused depth of water that is sufficient for kelt migration. As such, the depth of water that will be present within each smolt pass will exceed the depth of water that is available for kelts to utilise over the weir crest during comparable periods of low loch level/flow under the current site configuration.

Under the low loch level design case of **15.40 mAOD**, the adjustable inlet arrangement would maintain a minimum water depth of approximately **1.20 m** at the entrance to each smolt pass and **0.60 m** through the controlling section at the crest of each smolt pass (Fishtek drawing no. 0104-3540681-P01). These retained depths are considered sufficient for downstream passage of salmon kelts and represent an improvement to the conditions available to kelts over the existing weir crest during comparable low loch level conditions. Under the most significant climate adjusted drought event assessed in the optioneering report, the loch level is predicted to fall to a median level of 15.11 mAOD for the 15-minute minimum flow. During these conditions, minimum depths of 0.91 m and 0.31 m would be maintained at the inlet and crest of each smolt pass, respectively. These depths are deemed sufficient for the downstream passage of kelts under drought conditions.

[2] Simmons, O. M., Silva, A. T., Forseth, T., Andreasson, P., Müller, S., Calles, O., & Aldvén, D. (2024). Swimming behaviour of Atlantic salmon kelts migrating past a hydropower plant dam: Effects of hydraulics and dam operations. *Science of the Total Environment*, *922*, 171304.
[3] Nyqvist D, Nilsson PA, Alenäs I, Elghagen J, Hebrand M, Karlsson S, Kläppe S, Calles O. 2017. Upstream and downstream passage of migrating adult Atlantic salmon: remedial measures improve passage performance at a hydropower dam. Ecol Eng 102:331–343.
[4] Wertheimer RH. 2007. Evaluation of a surface flow bypass system for steelhead kelt passage at Bonneville Dam, Washington. N Am J Fish Manage. 27(1).

3. Fishtek Optioneering Summary, Section 7 — Management of flows across all passes at low water levels

NatureScot's question:

We are looking for evidence-based assurance that it is possible in principle to manage flows across all passes simultaneously in the manner described, in particular at low flows during the smolt season as per 7.2.2. How will levels and flows be monitored, what sort of adjustment mechanisms will be deployed at each passage route, and how quickly will they react to maintain flows? What sort of measures would be taken to mitigate the risks associated with that system failing?

The principle of mechanical control of fish pass channels in response to river levels and/or flow is well founded and can be delivered in a robust and reliable manner given appropriate civil, mechanical and electrical design. Relevant operational examples from elsewhere in the UK include:

- Spey Dam fish pass – a large pool and traverse fish pass with multiple controlling penstocks on the dam face. The penstocks open and close in response to measured water level within the reservoir, maintaining an appropriate inflow to the fish pass and ensuring that the fish pass remains passable for upstream migrating fish across a wide variation in reservoir water levels (Figure 1).

Figure 1. Fish pass inlet penstocks on the upstream face of Spey Dam shown during a period of reservoir drawdown. Individual penstocks are set at different inverts and open and close automatically in a pre-defined manner in response to measured reservoir water levels.

This example is directly comparable to the arrangement proposed at Dochfour as it involves multiple flow control structures that are operated individually in response to measured water level, but governed by an overarching control philosophy.

- Linton hydropower scheme – a large, hinged Larinier fish pass on hydraulic rams that adjusts in response to river level to maintain a constant flow through the fish pass regardless of changes in level/flow.
- Scandale Beck hydropower scheme – a passively adjusting notch at the inlet to a technical fish pass alongside the hydro intake that adjusts in response to river level to maintain a constant flow through the fish pass regardless of changes in level/flow.
- West Bay, Dorset – a fish pass at the tidal limit of a river with an automated sluice gate that closes off at low tide to prevent the upstream pool from emptying, before re-opening on the flood tide to enable upstream fish passage.

The reliable operation of the smolt passes will be underpinned by a number of critical mechanical and electrical elements. The arrangement will be subject to further development during the detailed design phase but it is anticipated that the operation will be based on the following core design principles:

- General control philosophy: level sensors will be installed adjacent to the inlet to each smolt pass, alongside the wider adjustable weir. These sensors will provide real-time recording of changes in water level in Loch Dochfour which will be sent to a SCADA control system.

- Depending on the recorded loch level, the control system will send a command to each individual flow control structure to adjust upwards or downwards incrementally to enable each channel to maintain an appropriate flow and water depth for fish passage.

- The SCADA system can coordinate individual control of each structure based on an overarching control philosophy with individual structure rules. This will allow, for example, the smolt channels to consistently maintain lower invert levels than the main adjustable weir structure, ensuring the channels provide a preferential flow route for migration.

- Final actuator selection has not yet been undertaken, as this would only be appropriate at detailed design stage. However, the response time for the control system would be expected to be measured in minutes rather than hours. Level readings, SCADA processing and command signals would effectively be real-time for this application, with the limiting response time being the mechanical movement of the relevant adjustable element. This is substantially faster than the rate of natural loch-level variation and is considered sufficient to maintain the intended distribution of flow across the fish passage structures. Final actuator speeds and control deadbands will be set during detailed design to maintain fish passage requirements while avoiding abrupt hydraulic changes.

- Flow through each route would be managed using calibrated relationships between upstream level, downstream level, adjustable structure position and channel geometry. These level / position / flow relationships would be developed during detailed design and verified during commissioning, so that the control system manages not only water level but the intended distribution of flow across the fish passage structures.

- To mitigate against the unlikely event of power loss, signal failure, sensor fault, actuator failure or obstruction of an inlet structure, the system would be designed with defined failure-mode responses. Each adjustable element would have a defined fail-safe position, commonly achieved through mechanical design such as counterweights, spring return or equivalent passive-return arrangements. Telemetry alarms would alert the system operator to power, signal, actuator or sensor faults, and manual override would be provided so that the structures can be placed into an appropriate operating position if automatic control is unavailable. Sensor arrangements would be developed during detailed design and may include duplicated or cross-checked level sensing where appropriate. Routine inspection and maintenance, including debris inspection and clearance at the smolt pass inlets and fish pass control structures, would form part of the operational management regime. The fail-safe position of each inlet structure will be determined during detailed design, balancing the requirements to maintain fish passage under the expected range of loch levels without risking excessive drawdown of the loch.

- During low-flow conditions, including the low-flow smolt-season scenario considered in Section 7.2.2 of the Optioneering Summary, the control philosophy would allow flow to be prioritised between the available fish passage routes according to seasonal biological need. For example, during the smolt migration season, the smolt pass inlets can be maintained as preferential surface flow routes relative to the wider adjustable weir crest, while maintaining appropriate upstream passage provision. This is a key benefit of using individually adjustable structures governed by an overarching control philosophy, rather than relying on fixed crest levels alone.

The detailed control system will be developed during detailed design, but the principle of simultaneous managed flow allocation across multiple adjustable hydraulic structures is well-established engineering practice. The examples above demonstrate that fish passage structures can be reliably controlled in response to changing water levels where appropriate civil, mechanical, electrical and control-system design is provided.

The Applicant confirms that the detailed design of the fish pass control system, including level sensing, flow monitoring, SCADA / PLC logic, actuator control, telemetry alarms, manual override and fail-safe operating positions, will be developed at detailed design stage and secured through the relevant design approvals, CEMP, method statements and planning conditions as appropriate.

4. Construction Disturbance document, §3 — Construction sequencing / monitoring

NatureScot's comment:

This will also need to factor in the installation and validation / optimisation of the chosen monitoring apparatus described in Fishtek Optioneering Summary Rev 004.

The Applicant confirms that the installation, commissioning, calibration, validation and optimisation of the selected monitoring apparatus, including the temporary fish pass counter where used, will be incorporated into the construction programme and sequencing. This will include a period of validation and, where appropriate, parallel operation with existing or supplementary methods before the monitoring system is relied upon as the primary operational tool. These commitments will be secured through the CEMP, method statements and relevant planning conditions or detailed design approvals as appropriate.

5. Construction Disturbance document, §5.5 — ECoW role / avoidance monitoring

NatureScot's question:

What approaches/methods would the ECoW use to assess whether fish are exhibiting sustained avoidance of the operative passage routes that can be attributed to vibro-piling activity? As it is likely to be a dynamic environment where visibility is sub-optimal we are looking for evidence this is possible in principle and/or whether alternative actions/approaches may be needed as a backup if it proves impossible in practice.

The construction noise and disturbance strategy distinguishes between impact piling and vibro-piling. Impact piling, where required, has greater underwater noise and disturbance potential and is therefore programmed within the November–December core works window, with late October and early January shoulder periods used only where confirmed appropriate by the ECoW. Vibro-piling is the preferred lower-impact method for temporary cofferdam works and may be undertaken outside the core window, subject to ecological controls, but will not occur during the smolt migration period from April to mid-June.

NatureScot's question is in relation to the ECoW monitoring approach during vibro-piling outside the core impact-piling window. During such works, the purpose of ECoW monitoring would be to identify whether fish are exhibiting a sustained adverse response at the operational passage routes that is consistent with avoidance behaviour attributable to vibro-piling activity. The monitoring is not intended to provide forensic attribution of every individual fish movement, but to provide a practical, evidence-based means of identifying a sustained adverse signal and triggering a precautionary response, if required.

To enable the ECoW role to assess potential disturbance, video camera monitoring will be included within the entrance and exit of the temporary fish pass, utilising a technology that allows footage to be processed and interpreted automatically in real time (e.g. TiVA camera with AI species recognition, or similar). Data from the monitoring will represent the primary means through which potential migration disturbance during periods of vibro-piling will be assessed, informed by consideration of the following aspects:

1. A change in the total counts of migrating salmon or the diel timing (day *vs* night) of migration during periods when vibro-piling is taking place, compared to migration trends across immediately preceding days where no piling activity occurred. Triggers that would lead to a temporary cessation in piling, or a change in piling approach, would include a measurable reduction in total daily migration counts through the temporary fish pass compared to the preceding period, or a change in migration timing (e.g. a measurable skew in migration away from daylight hours compared to the preceding period).
2. Of those salmon recorded entering the temporary fish pass (detected by the camera at the downstream end), a measurable reduction in the proportion successfully exiting the temporary fish pass into the loch upstream (detected by the camera at the upstream end) would be treated as a potential adverse signal. Equally, a measurable increase in the proportion of fish failing to exit successfully, or repeatedly entering and rejecting the passage route, would be treated as a potential adverse signal. Triggers that could lead to a temporary cessation in piling, or a change in piling approach, would include a sustained increase in passage rejection compared to the immediately preceding non-piling period.
3. Supplementary visual inspection of the fish pass and the downstream weir pool during appropriate flow and visibility windows to identify any evidence of disturbance that may

be consistent with avoidance behaviour potentially attributable to vibro-piling. This would include, for example, retention of individual fish within the fish pass and reluctance to exit, or milling/retention within the downstream weir pool.

Subject to availability of data, the temporary fish pass monitoring would be supplemented by a parallel review of migration activity from the resistivity fish counter at the Hydro Ness site downstream of Dochfour weir, operated by The Highland Council. Data from the Hydro Ness fish counter would therefore give an improved understanding of whether salmon are still actively migrating towards Dochfour weir before, during and after periods of vibro-piling. This would assist interpretation of any low or variable counts recorded at the temporary fish pass, recognising that such patterns may reflect wider migration conditions rather than avoidance of the operational passage routes at Dochfour. However, the proposed monitoring and mitigation approach does not depend on access to the Hydro Ness data.

The interpretation of any monitoring signal would be undertaken by the ECoW/fisheries specialist, taking account of river flow, loch level, weather conditions, time of day, recent migration trends and, subject to availability, historical and/or real time Hydro Ness fish counter data. This is important because low or variable counts may reflect natural migration patterns rather than construction-related avoidance. The monitoring approach is therefore intended to identify a sustained adverse signal consistent with avoidance behaviour, rather than to attribute every short-term fluctuation in passage activity to construction works.

Monitoring data would be reviewed daily during periods of vibro-piling. Any potential adverse signal would be assessed by the ECoW/fisheries specialist in consultation with the site team, with the response proportionate to the strength and persistence of the signal.

If monitoring data are inconclusive, or if visibility, equipment performance or low migration activity prevents reliable assessment during a relevant period, the fallback response would be to apply precautionary construction controls. These may include temporary cessation of vibro-piling, rescheduling works, reducing piling intensity, revising the timing of works within the day, increasing fisheries specialist review, or maintaining a pause until adequate monitoring confidence is restored.

Appendices

Appendix 1 - Photographic Tailwater Scaling Pack

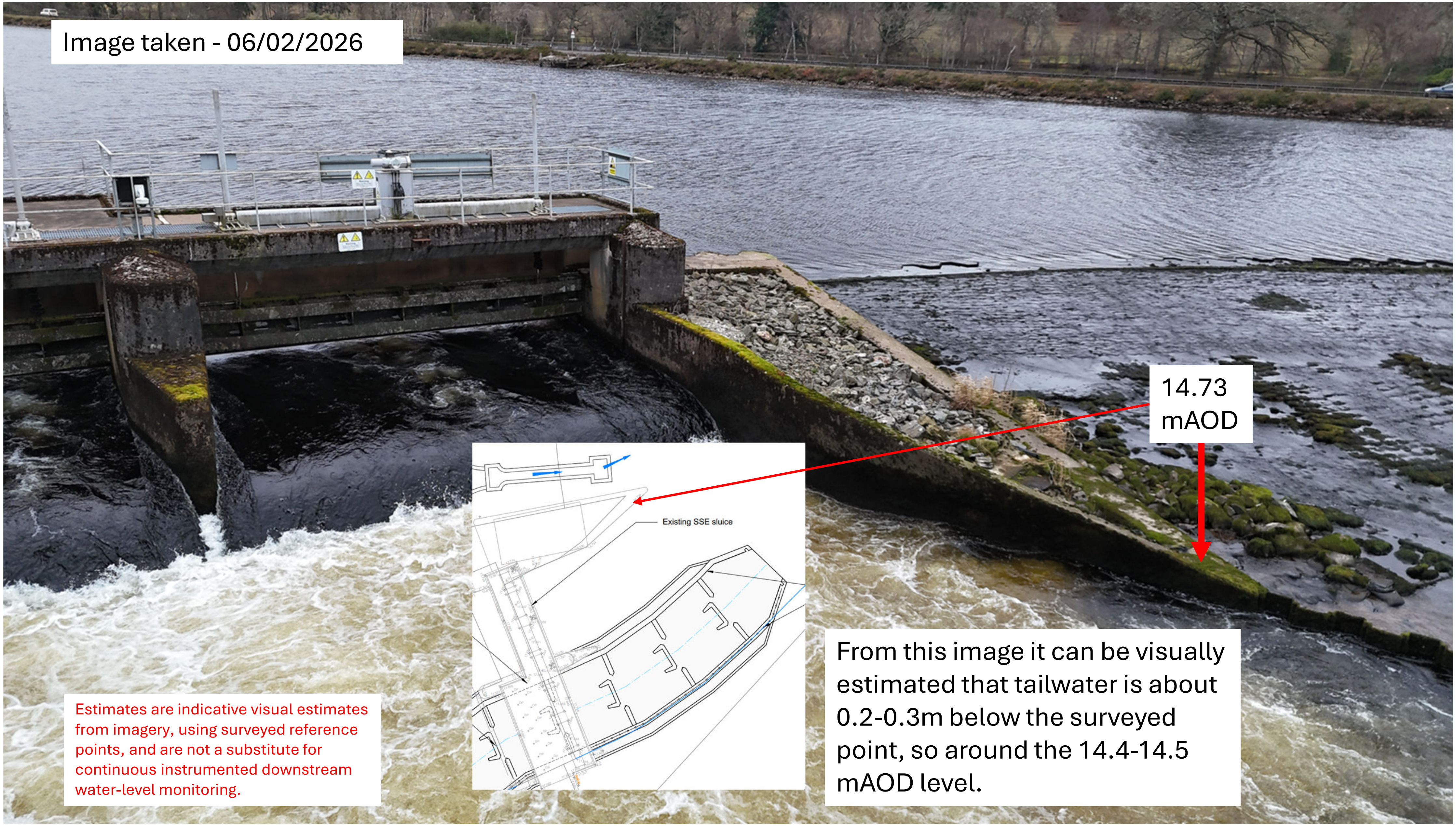
Image taken - 06/02/2026
14.73
mAOD
Existing SSE sluice
Estimates are indicative visual estimates from imagery, using surveyed reference points, and are not a substitute for continuous instrumented downstream water-level monitoring.
From this image it can be visually estimated that tailwater is about 0.2-0.3m below the surveyed point, so around the 14.4-14.5 mAOD level.

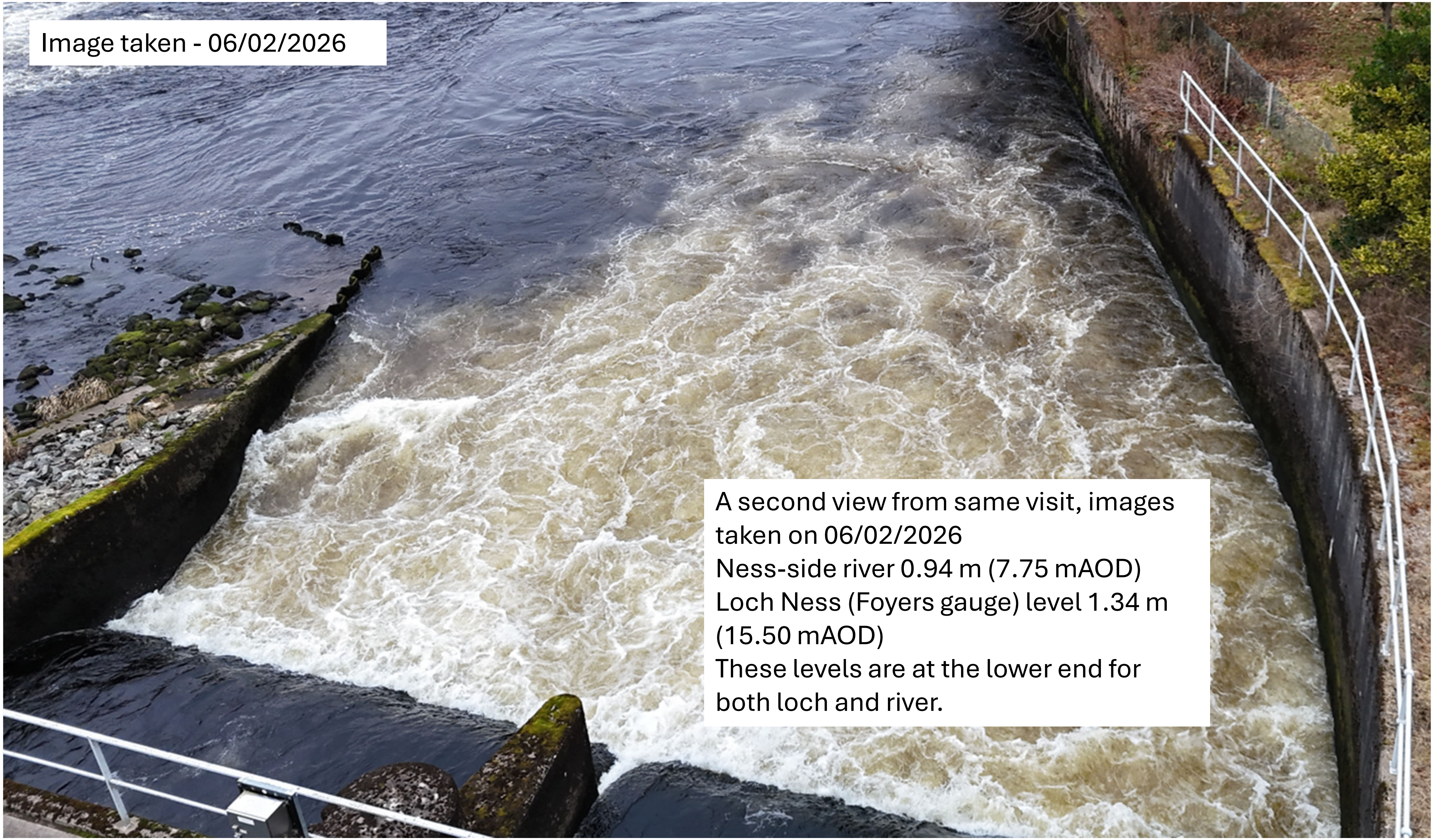
Image taken - 06/02/2026
A second view from same visit, images taken on 06/02/2026
Ness-side river 0.94 m (7.75 mAOD)
Loch Ness (Foyers gauge) level 1.34 m (15.50 mAOD)
These levels are at the lower end for both loch and river.

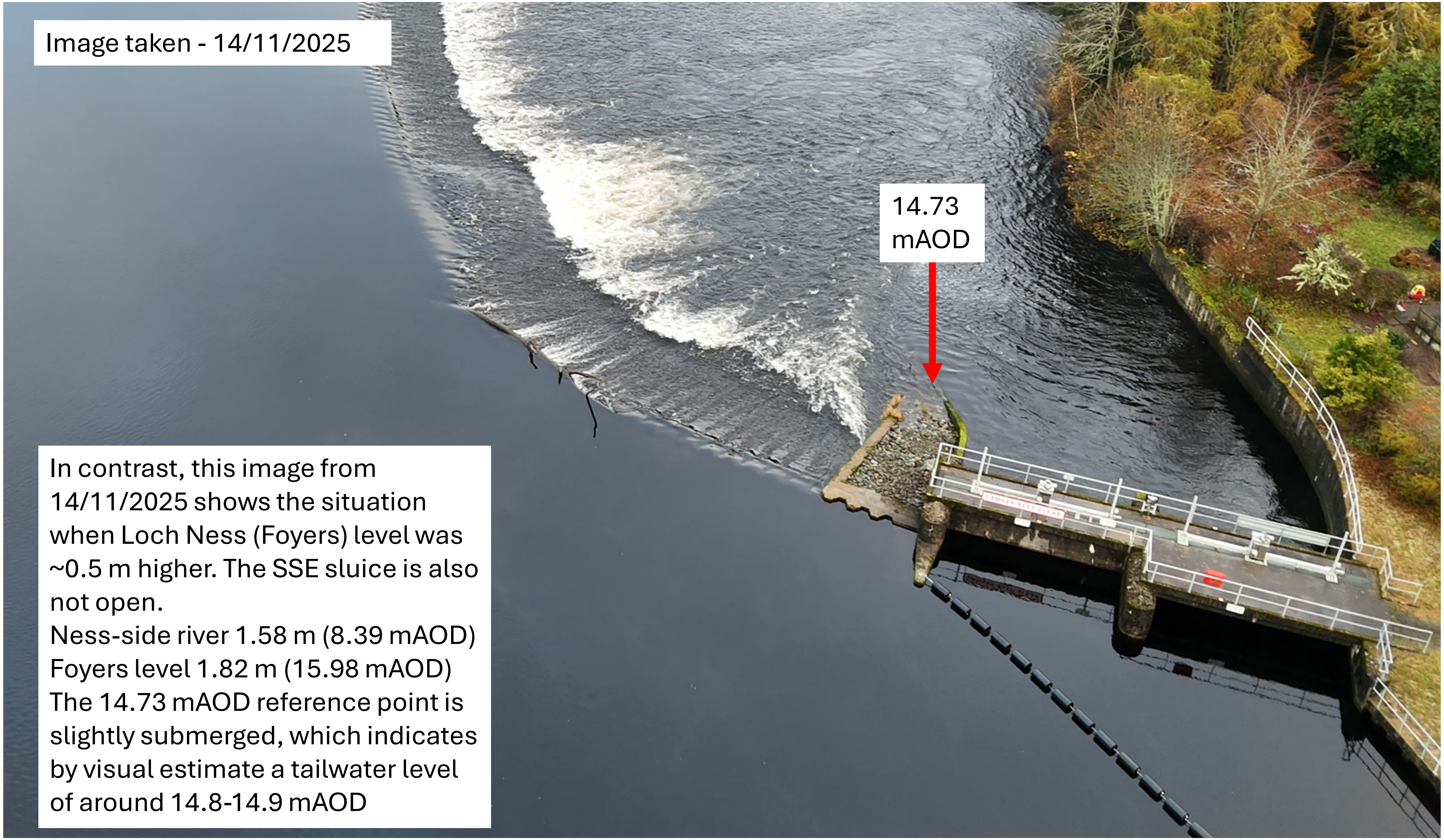
Image taken - 14/11/2025
14.73 mAOD
In contrast, this image from 14/11/2025 shows the situation when Loch Ness (Foyers) level was ~0.5 m higher. The SSE sluice is also not open.
Ness-side river 1.58 m (8.39 mAOD)
Foyers level 1.82 m (15.98 mAOD)
The 14.73 mAOD reference point is slightly submerged, which indicates by visual estimate a tailwater level of around 14.8-14.9 mAOD

Image taken - 14/11/2025

Another pair of images from the same date, 14/11/2025