

March 2025

Glen Earrach Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 5: Appendices
Appendix 2.1: Dochfour Weir Upgrade Description

Glen Earrach Energy Ltd

Quality information

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Issue History

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1. Introduction

1.1. General

- 1.1.1. Initial assessments of the impacts on Loch Ness due to the Proposed Development (including cumulative impacts) identified the potential for significant effects on certain sensitive receptors, associated with water level variation in Loch Ness and downstream flows in the River Ness. To mitigate these impacts, it is proposed that upgrade / improvement works at Dochfour Weir will be undertaken.
- 1.1.2. The weir upgrade works proposals are being developed in close collaboration with Scottish Canals and will be the subject of a separate planning application, please refer to **Appendix 2.2: Dochfour Weir (Scottish Canals Letter) (Volume 5: Appendices)**. It is proposed that the upgrade works are the subject of a condition attached to any consent granted for the Proposed Development.
- 1.1.3. This Appendix explains the context for the proposals, their objectives and details the upgrade / improvement works proposed on the weir.

1.2. Background

- 1.2.1. The Thomas Telford designed Dochfour Weir (referred to as the 'Telford structure') was constructed between 1825 and 1830 as part of the Caledonian Canal and had the effect of elevating the upstream river level by approximately 1.2 m, leading to the flooding of the riverside back to Loch Ness and the creation of an expanded Loch Dochfour. Its purpose is to ensure that water levels in Loch Ness are sufficient to feed the canal and maintain minimum draft for boats.
- 1.2.2. When water levels are high enough, water spills over the fixed level weir into the River Ness. At lower loch levels, water discharges through the fish pass with small flows through the smolt pass. Some water is also exchanged through the adjacent Caledonian Canal lock gates. There are also two rising gates within the weir structure, operated by SSE, which allow water to be discharged through the weir as required to ensure statutory minimum flows are met in the River Ness.
- 1.2.3. The water level in Loch Ness currently varies throughout the year due to natural catchment flow changes, ranging from approximately 15 m Above Ordnance Datum (AOD) to 17 m AOD, including during drought and flood scenarios. These fluctuations are generally seasonal but can sometimes occur over much shorter periods, including weekly. The detail of these levels is noteworthy as they are referred to in **Section 3 Weir Modifications**. The levels are summarised in the below **Table 1. Water Levels**.

Table 1. Water Levels

Feature	Level (m AOD)	Notes
Mean Water Level in Loch Ness	15.82	
Max Level recorded at Loch Dochfour	17.02	In period of high flow / flood events there is a difference in Loch Dochfour and Loch Ness levels due to the Bonar narrows constraint.
Dochfour (service) weir crest	15.53	Refer to Figure 2.1.1 Dochfour Weir Modification Works (Annex A Figures)
Dochfour (waste) weir crest level	15.73	Refer to Figure 2.1.1 Dochfour Weir Modification Works (Annex A Figures)
Dochfour weir fish pass level	14.92	
Caledonian Canal minimum navigation level	15.27	

- 1.2.4. The cumulative assessment undertaken as part of this Environmental Impact Assessment (EIA) has shown that the operation of multiple Pumped Storage Hydro (PSH) schemes is expected to cause a variation to loch levels in Loch Ness and to existing flows in the River Ness. To mitigate the potential for significant effects, it is proposed to upgrade the existing passive weir to become a variable control weir, which will have the control of downstream flows into the River Ness as a primary function.
- 1.2.5. Details of the cumulative assessment with respect to water resources and flooding can be found in **Chapter 11: Water Resources and Flood Risk (Volume 2: Main Report)**.

1.3. Scope of Work

- 1.3.1. The primary objective of this appendix is to summarise the outline proposals for the amendments to the Dochfour Weir, considering the interests of all stakeholders, environmental concerns and sustainability.
- 1.3.2. This appendix also details the existing features of the weir and presents options for enabling variable control.

2. Existing Weir

2.1. Existing Structure and Site Access

- 2.1.1. The current weir has two principal components being: (1) the service weir, which incorporates the fish pass and the two under sluice gates and (2) the waste weir which incorporates the smolt pass. Refer to **Insert 1 Existing Dochfour Weir** for details of the existing weir.



Insert 1 Existing Dochfour Weir¹

- 2.1.2. The weir spans a distance of approximately 525 m. In 2017 to 2018 steel sheet piling was added by Scottish Canals to reinforce the weir structure to ensure its future stability.
- 2.1.3. The existing fish pass is a lowered section in the weir without pools. The smolt pass is a narrow channel in the waste weir.

¹ Google Earth Pro, (2025) Lochgarroch Loch, Inverness. 5725'34.96" N, 418'40.20" W, Eye alt 1.02 km. <http://www.earth.google.com> [April 11, 2025].

- 2.1.4. SSE owns and operates the existing manually controlled rising sluice gates, which are currently used to comply with River Ness flow requirements.
- 2.1.5. The baseline water level data and flow data used for the purpose of the water resource assessment includes periods when the sluice gates are in operation. The current operation of the gates is therefore captured in the baseline conditions.
- 2.1.6. An unnamed road off the B862 near Balmore Farmhouse provides access to the south side of the weir and the sluice gates. A public footpath from the north extends to the end of the waste weir which can be accessed on foot via the Dochgarroch Lock off the A82.

3. Weir Modifications

3.1. Concept Development and Objectives

- 3.1.1. It is recognised that operation of the Proposed Development will cause fluctuation in water levels on Loch Ness and, without mitigation, there may be environmental effects as a consequence. It is also recognised that the current “system” of managing loch levels is sub-optimal i.e. the effects of the existing upstream hydropower facilities can only be controlled through the existing sluice gates at the Dochfour Weir and these are unable to provide any better outcomes, both in relation to flood flows and environmental issues. This is exemplified by the long-standing issues associated with the current fish and smolt passes.
- 3.1.2. The Applicant recognised at an early stage that engagement with other key stakeholders would be essential to identify potential solutions. This has led to extensive dialogue with Scottish Canals in particular, and with other key water environment stakeholders such as the Ness District Salmon Fisheries Board (NDSFB), The Highland Council, SEPA, NatureScot and SSE.
- 3.1.3. Consultation has been positive and there is recognition that amendments to the weir and its operation could be beneficial. The objectives of these amendments are as follows:
 - Maintain natural flows in River Ness irrespective of PSH activity in Loch Ness;
 - As part of maintaining natural flows, avoid ‘artificial’ loss of water from Loch Ness and Loch Dochfour during the summer months because of any daily variation in levels due to PSH activity;
 - Protect the navigability of the Caledonian Canal, even in the case of extensive dry periods, which are anticipated to increase as part of likely climate change scenarios;
 - Improve the fish passage arrangements at the Dochfour Weir, both to address existing issues of smolt loss and therefore improve the current performance of the weir in this regard, and to ensure that any additional PSH activity does not result in a detrimental impact on fish passage;
 - Maintain the flood carrying capacity of the existing Dochfour Weir structure, requiring that the current sill level be maintained during flood events, noting that through the improvement works, additional flood capacity might also be considered to address future climate change concerns;
 - Avoid direct impact to the cultural heritage elements of the Ness Weir associated with Telford’s original construction; and
 - Establish a water management board which includes representation from key stakeholders of Loch Ness and Loch Dochfour in order to ensure the coordinated and transparent operation of the upgraded weir.

3.2. Concept Description

- 3.2.1. To achieve these objectives, The Applicant has proposed the concept of a variable level control element to be installed just upstream, and along the full length, of the existing Dochfour Weir. The variable weir is intended to operate as follows:

- The variable weir would raise and lower according to flow data received from the existing and any future constructed PSH projects, such that the flows into River Ness would be the same as though there were no PSH activity.
- The flow in River Ness would therefore be maintained as a natural flow, while in doing so, there would be no 'artificial' loss of water during summer months due to PSH activity, maintaining navigability of the Caledonian Canal.
- The flow over the weir would maintain the character of the existing flow, generally being a curtain of water passing over the full length of the weir (even when gates are in their raised condition).
- The variable weir operation would be restricted in winter months, recognising the need to maintain flood resilience, with the maximum operating point being set such that it is possible to lower the weir to the current Ness Weir sill level with notice of possible flood without causing excessive flow in River Ness while doing so.
- The existing fish pass provision would also be modified and modernised, and this would include a variable element to ensure that any PSH activity would improve fish passage.
- The variable weir would be located upstream of the Telford structure to avoid direct impact to this cultural heritage asset, while maintaining the character and preserving the setting of the existing weir.
- A water management board would be established involving key stakeholders of Loch Ness, with the responsibility to oversee the control approach adopted, taking account of the flow data received from each of the PSH schemes on Loch Ness.

3.3. Engineering Design

- 3.3.1. The current weir is an unregulated structure. In order to satisfy the objectives above, a regulated structure is required. It was quickly established that an adjustable gated weir would be needed to maintain the existing weir crest at its current level but with the ability to vary gate level over the full width of the weir as necessary to control flows to the River Ness and, consequently, levels in Loch Ness.
- 3.3.2. Importantly, the proposed approach does not include a permanent raising of the weir, which was quickly discounted as this would reduce the flood carrying capacity of the structure and would increase flooding risk on the A82.
- 3.3.3. The existing weir lacks consistent curvature. Therefore, all three crest levels for the fish pass, service weir, and waste weir would need to be modified to accommodate the gates. Two types of gates, either pneumatically or hydraulically operated, can be installed to regulate the flow over the weir.
- 3.3.4. The crest levels of the existing weir are set at 15.53 mAOD for the service weir and 15.73 mAOD for the waste weir, making the waste weir 0.2m higher. An assumed priority for the stakeholders is to maintain these levels and minimise modifications to the existing weir structure. The proposed modification works for both the service and waste weir are outlined in **Figure 2.1.1 Dochfour Weir Modification Works (Annex A Figures)**.
- 3.3.5. The proposed solution has no construction impact on the downstream face of the weir, to avoid unnecessary impacts on the original Telford structure. Considering the assumed bathymetric profiles of the canal, the water depth is expected to be in the range of 2 to 3m along the upstream side of existing service weir, including the fish pass. Additionally, the navigation channel is further away from the upstream edge and closer to the A82 bank, where the channel is significantly deeper.
- 3.3.6. As part of the weir modification works set out in this Appendix, the existing fish pass and smolt pass arrangements will be replaced with new or improved structures, the design of which will be done in close consultation with stakeholders and in line with SEPA guidelines and requirements.
- 3.3.7. Additionally, there is a perceived issue regarding the loss of salmon smolts into the Caledonian Canal. To address this issue and in collaboration with stakeholders an acoustic fish barrier is proposed between the weir and the canal. It is believed that this solution can minimise fish movement towards the canal, enhancing the performance of the overall weir structure for fish.

3.3.8. To control and construct the proposed weir gates, a control room building and abutments are required and are shown indicatively on **Figure 2.1.1 Dochfour Weir Modification Works (Annex A Figures)**. The number and positions of the control room buildings will be based on suppliers' specification requirements for installation and operation in the next design stage. The construction sequence for the weir modification is summarised as follows:

- Formation of construction access;
- Installation of piles to the front face of the weir;
- Construction of abutments;
- Concrete works for resurfacing the top of the existing weir to match the requirements for installation of the air bladder / control mechanism for the spillway gates and the frames of the gates themselves;
- Installation/amendment of the fish pass and smolt pass mechanisms;
- Construction of control cabin / buildings;
- Construction by-pass and coffer dam (if the under sluice needs to be replaced);
- Compensation flow works;
- Installation of acoustic barrier;
- Installation and commissioning of variable weir; and
- Reinstatement works.

3.4. Weir Gate Description

3.4.1. There are a limited number of gate types which may be suitable to allow the weir crest level to be raised or lowered to regulate the flow in the River Ness. The favoured pneumatically operated gate type is briefly described in the following sections.

Pneumatically Operated Gates

3.4.2. These gates can be either hydraulically or pneumatically actuated, suitable for controlling water levels up to a 2 m range. Details in this section refer to pneumatic systems; details are slightly different for hydraulically actuated systems. Generally, the gates feature prefabricated standard gate panel units 6m in width. As noted above, the crest levels of the existing weir are 15.53m AOD for the service weir and 15.73m AOD for the waste weir, making the waste weir 0.2m higher. The priority is to maintain these levels and minimize the extent of modifications to existing structures.

3.4.3. For configuration details, refer to drawing Figure 2.1.1 Dochfour Weir Modification Works (Annex A Figures).

3.4.4. This gate type is relatively straightforward to install and can be configured for controlled failsafe closure which, in this case, will mean gradual release of water held above fixed weir height by deflation of the air bladders. The actuation of the individual gate segments will be maintained independent such that no single point of failure can result in more than one gate segment either remaining in position (on a lower command) or lowering when in the raised position. Consultation with an industry leading supplier, Dyrhoff, indicates that their spillway gate solution will provide the necessary level and flow control.

This type of inflatable gate has minimal visual impact, both inflated and deflated, as it is covered by either the minimum water level in the deflated condition or by the curtain of water flowing over the weir if in a raised condition.

Variable Weir Assessment and Controls

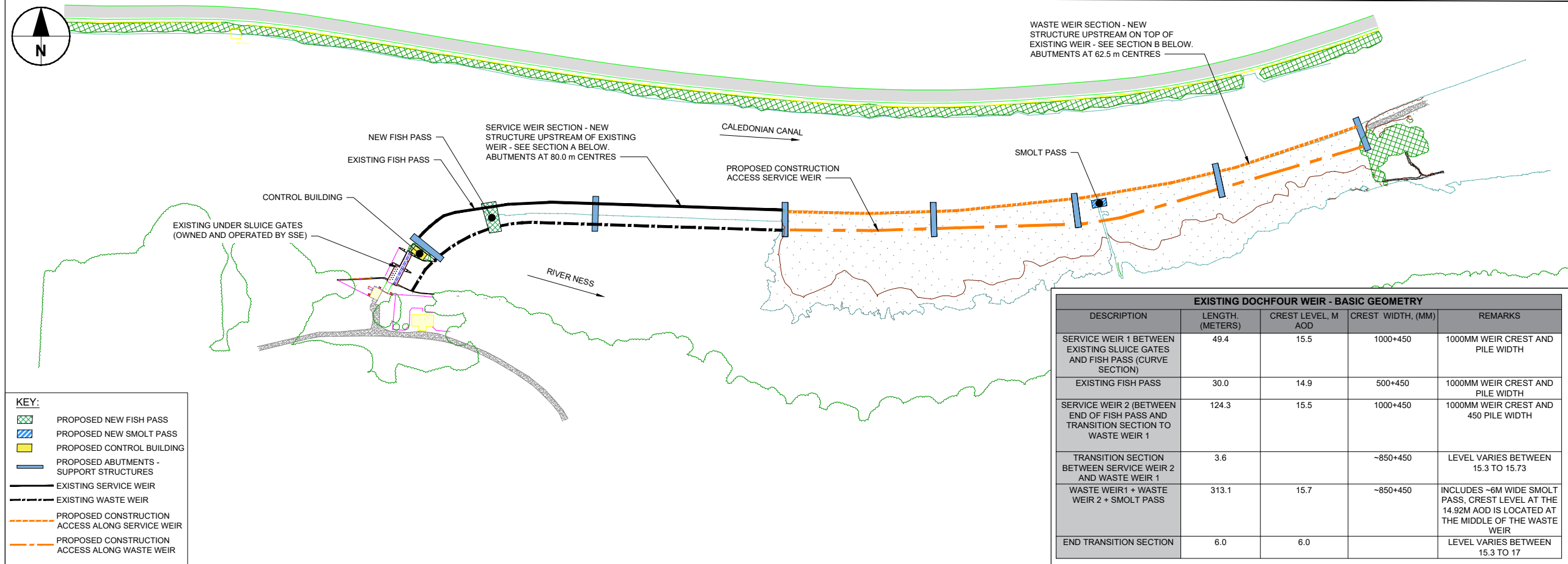
3.4.5. The general premise for the variable weir would be to 'decouple' loch level changes and consequent variation in outflows to River Ness due to PSH scheme operation from "natural" catchment variation. The variable weir would be raised to contain the PSH generating flows within Loch Ness, and lowered during pumping, thus isolating the flows in the River Ness from the impact of the PSH activities. This would result in a more natural flow in the River Ness controlled by metrological conditions rather than PSH activities.

- 3.4.6. An “active water level control” system is proposed, where, for example, if raising the weir to contain the full volume associated with PSH scheme activities would raise the loch level beyond its normal range or downstream flows would fall below a set threshold, raising would be limited to mitigate and more flow released downstream. This will allow both loch levels and river flow to be optimised for stakeholders.
- 3.4.7. A control schematic for an Active Water Level Control (AWLC) regime will need to be fully developed to demonstrate how the variable weir would operate safely and optimise all benefits in continuous service. Such a system will require a number of inputs, including the following:
- Real time operating data from all PSH schemes;
 - Real time loch level data; and
 - Meteorological data.
- 3.4.8. The AWLC function will be to continually raise or lower the weir crest level to compensate for varying conditions, rising during net inflows and falling during net (e.g. pumping) outflows. The automatic system will need to recognise potential flood events and take mitigating action.
- 3.4.9. Importantly, the weir is proposed as a seasonal variable weir. Full level regulation would only occur during the summer period. The operation of the regulating element of the weir during the winter will be limited in terms of maximum raise such that it is always possible to completely lower the weir to the existing sill level within a maximum of one day’s notice of a potential flood event, without causing excessive flow in River Ness during the process of lowering.

4. Conclusions

- 4.1.1. It has been identified that the Proposed Development has the potential to affect certain sensitive receptors associated with flows in the River Ness and water levels in Loch Ness.
- 4.1.2. The Applicant intends to deploy mitigation in relation to this in the form of upgrade works to the Dochfour Weir, which will allow active control of loch levels, with associated environmental benefits as summarised below:
- Replacement / upgrade to the existing smolt pass;
 - Replacement / upgrade to the existing fish pass; and
 - Converting the weir to a regulated weir design.
- 4.1.3. The primary function of the automated regulated weir will be to decouple flows in the River Ness from the operation of existing and proposed PSH schemes, including the Proposed Development. The Applicant is continuing to engage with Scottish Canals to confirm the final design and approach to complete these works.

Annex A Figures



PROJECT

GLEN EARRACH PUMPED STORAGE HYDRO

CLIENT

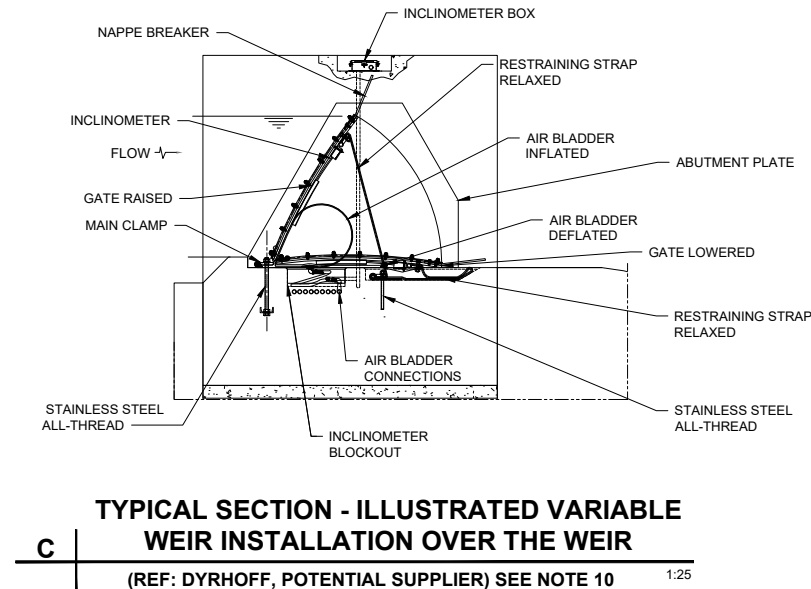
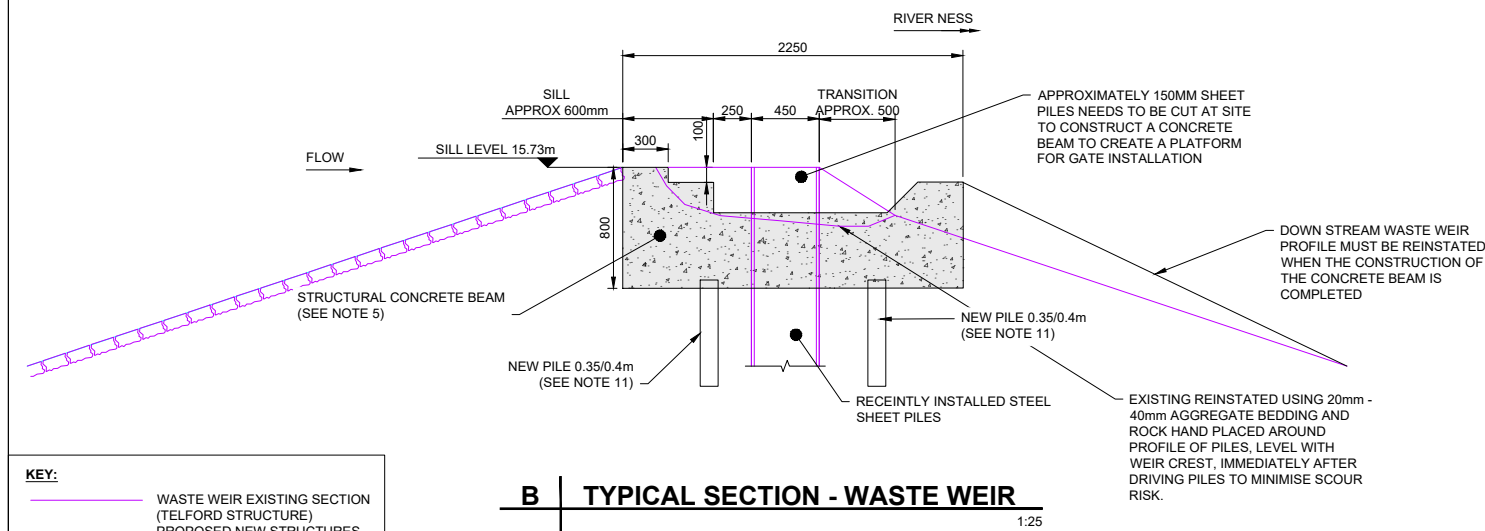
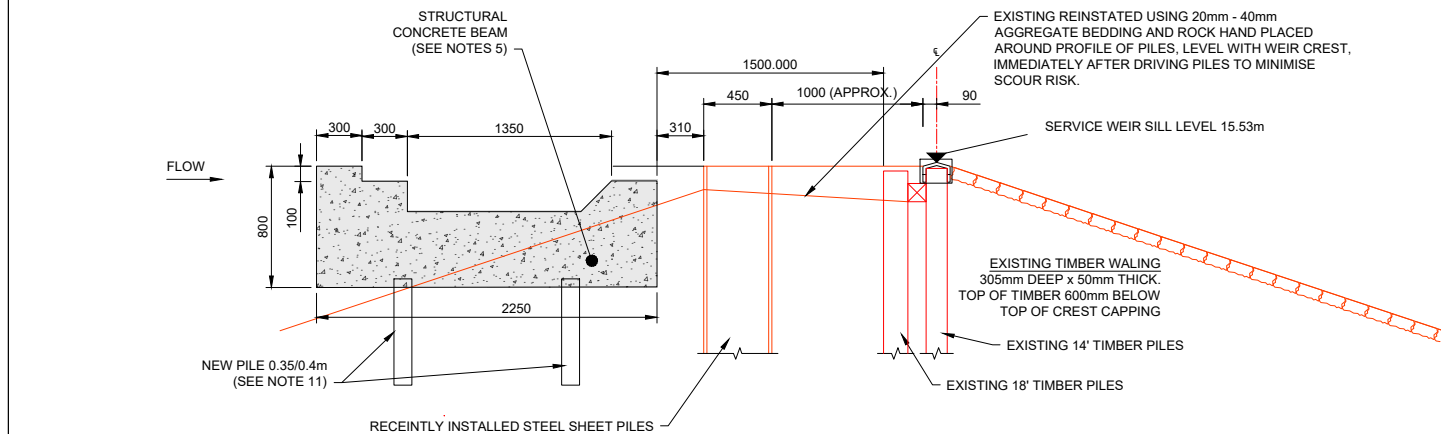
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- NOTES**
- THIS DRAWING IS FOR INDICATIVE PURPOSES ONLY. TYPICAL SECTIONS FOR MODIFYING THE SERVICE AND WASTE WEIR OF THE EXISTING DOCHF0UR WEIR ARE CONCEPTUAL.
 - ALL DIMENSIONS ARE IN MILLIMETERS (mm) UNLESS OTHERWISE STATED. ELEVATIONS ARE RECORDED IN METERS ABOVE ORDNANCE DATUM (mAOD).
 - THE EXISTING FISH PASS NEEDS TO BE REPLACED. A NEW FISH PASS MUST BE DESIGNED AND CONSTRUCTED IN COMPLIANCE WITH SEPA GUIDANCE.
 - CONCEPT INVOLVES MODIFYING THE SERVICE WEIR IMMEDIATELY UPSTREAM OF THE EXISTING WEIR EDGE WHILE KEEPING THE DOWNSTREAM FACE OF THE WEIR UNDISTURBED.
 - CONCEPT INVOLVES MODIFYING THE SERVICE WEIR 1.5m TO THE WEST TO KEEP THE EXISTING WOODEN PILES UNDISTURBED.
 - EXISTING SHEET PILES ARE INSTALLED AT THE DOWNSTREAM EDGE OF THE WASTE WEIR. APPROXIMATELY 100mm OF THE EXISTING SHEET PILES AT THE TOP NEED TO BE CUT TO PROVIDE THE MINIMUM COVER AND ALLOW THE REBAR TO PASS WITHIN THE CONCRETE BEAM.
 - THE MODIFICATION WORK ALONG THE WASTE WEIR CAN BE DONE BY ESTABLISHING TEMPORARY ACCESS ON THE DOWNSTREAM SIDE OF THE WEIR.
 - CONSTRUCTION ACCESS ALONG THE SERVICE WEIR WILL DEPEND ON THE SELECTED OPTION FOR THE WEIR MODIFICATION WORKS.
 - INTERMEDIATE PIERS TO SUPPORT THE GATES ARE NOT SHOWN; THEIR SIZE AND POSITIONS WILL DEPEND ON THE TYPE OF GATES AND THE INSTRUMENTAL ARRANGEMENT FOR OPERATION.
 - THIS IS AN EXAMPLE ILLUSTRATION OF SPILLWAY GATE INSTALLATION WITH REGULATING WATER LEVEL FOR 1.1M RANGE. THIS ILLUSTRATION IS USED FOR SIZING AND MODIFYING EXISTING DOCHF0UR WEIR.
 - NEW PILES (EITHER STEEL / CONCRETE PILES WITH DIAMETER OF 0.35m / 0.4m) WILL BE REQUIRED TO SUPPORT THE PROPOSED CONCRETE PLINTH AND INTERMEDIATE PIERS. THE PILE MATERIAL, LENGTH, POSITIONS, AND SIZE WILL DEPEND ON THE FINAL STRUCTURAL AND FOUNDATION DESIGN.



ISSUE PURPOSE

Final

PROJECT NUMBER

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FIGURE TITLE

Dochfour Weir Moditification Works

FIGURE NUMBER

Figure 2.1.1

