Glen Earrach Energy
Urquhart Bay Wood SAC
Additional Information Submission: Ecological Summary and Supporting Technical Analyses

1. Introduction

This document compiles the ecological summary note and supporting technical analyses relating to Urquhart Bay Wood SAC and is provided as Additional Information to the Energy Consents Unit and consultees.

This material is provided specifically to address the further information requirement set out in NatureScot's letter of 11 November 2025 (Ref: CDM173569, Application Ref: ECU0005121). In that letter, NatureScot advised that further information was required in order to carry out an appraisal to inform the competent authority's appropriate assessment, specifically:

"Details of how much woodland will be inundated and for how long each inundation event will last above the current median summer loch level. This should be accompanied by a detailed fine scale map which clearly shows the areas of woodland likely to be inundated, together with current NVC type, colour coded to show the areas with the highest impacts."

Accordingly, this compiled submission includes the ecological summary note (*Further information on water levels and Urquhart Bay Wood SAC*) together with the supporting inundation and drying event analyses and associated technical outputs which informed that summary.

The ecological summary note provides a synthesis of the updated NVC mapping and the inundation and drying event analyses, and sets out our interpretation in respect of habitat sensitivity, species tolerance, and likely effect pathways for Urquhart Bay Wood SAC.

This document confirms the EIAR position remains unchanged: the Proposed Development would not result in an adverse effect on the integrity of Urquhart Bay Wood SAC.

2. Overview of Supporting Information

The material included in this compiled submission delivers the detailed technical information required to support ecological interpretation and to address the further information request.

This includes updated fine-scale NVC mapping for Urquhart Bay Wood SAC, incorporating field survey data from 2024, drone and on-foot reconnaissance footage, and LiDAR-derived terrain analysis to update NVC types across the site. The mapping distinguishes W7, W9, transitional zones, and associated swamp communities.

The mapping packs present the full SAC extent showing:

- habitat identification (NVC types), and
- level bands shown in colour coding.

This is supported by summary tables setting out, for each level band:

- area in hectares,
- the habitats present within that band, and
- the percentage of the total SAC represented by that band.

In addition, inundation extent mapping by level threshold (15.7 m AOD to 17.5 m AOD at 0.2 m intervals) is provided, showing predicted water areas at each level. For each level threshold:

- a map is provided showing the total area inundated at that level, not just the individual band, and
- level band contours are visible on the main NVC mapping sheet for context.

This includes tabulated data showing the area and percentage of SAC affected at each level threshold.

3. Inundation and Drying Event Analyses

This submission includes inundation event analysis and drying event analysis based on the seasonal variable weir operational scenario, including Glen Earrach PSH, Loch Kemp PSH and Loch na Cathrach PSH, with baseline comparison (which includes Foyers PSH).

For each level threshold, the analyses include:

- event duration distribution graphs,
- event duration summary statistics (median, 5%, 25%, 75% and 95% percentiles), and
- event counts by duration category (≤24 hours, 1–3 days, 3–7 days, >1 week).

Drying event analysis is provided in the same format and allows review of recovery opportunity between successive inundations.

All statistics are derived from an average year across the eight and a half year modelled dataset (January 2016 to July 2024), as per the data used in EIAR Appendix 11.1, aligned with the available generation data profile.

The inundation and drying analyses are presented for:

- the growing season (1 April to 31 October), and
- seasonal subsets (spring, summer, autumn and winter),

consistent with the operational regime described in the application.

4. Documents Included in this Submission

This compiled submission includes the following ecological summary and supporting technical appendix packs.

Ecological Summary

- **Urquhart Bay Wood SAC Further Information**

This document provides a synthesis of the updated NVC mapping and hydrological analyses and sets out interpretation in respect of habitat sensitivity, species tolerance, and likely effect pathways.

Drying Event Analysis Packs

These packs present analysis of drying periods between inundation events, allowing review of recovery opportunity between successive inundations:

- **GEE AI TA A1 – Drying event analysis, seasonal variable weir – autumn**
- **GEE AI TA A2 – Drying event analysis, seasonal variable weir – growing season**
- **GEE AI TA A3 – Drying event analysis, seasonal variable weir – spring**
- **GEE AI TA A4 – Drying event analysis, seasonal variable weir – summer**
- **GEE AI TA A5 – Drying event analysis, seasonal variable weir – winter**

Inundation Event Analysis Packs

These packs present analysis of inundation event frequency, duration, and seasonal characteristics:

- **GEE AI TA A6 – Inundation event analysis, seasonal variable weir – autumn**
- **GEE AI TA A7 – Inundation event analysis, seasonal variable weir – growing season**
- **GEE AI TA A8 – Inundation event analysis, seasonal variable weir – spring**
- **GEE AI TA A9 – Inundation event analysis, seasonal variable weir – summer**
- **GEE AI TA A10 – Inundation event analysis, seasonal variable weir – winter**

Due to file size, these drying and inundation event analysis packs are uploaded as separate files.

5. Purpose and Interpretation

The ecological summary note synthesises the mapping and event outputs and sets out interpretation in respect of habitat sensitivity, species tolerance and likely effect pathways.

On the basis of the updated fine-scale mapping and the inundation and drying event analyses, this submission confirms that the conclusions of the EIAR remain unchanged. Specifically, the Proposed Development would not result in an adverse effect on the integrity of Urquhart Bay Wood SAC.

Glen Earrach PSH

Further information on water levels and Urquhart Bay Wood SAC

February 2026

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Quality information

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Issue History

Issue	Issue date	Details	Authorised	Name	Position
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1. Introduction

1.1.1 Following the submission of the Environmental Impact Assessment Report (EIAR), which included **Appendix 7.2: Statement to Inform Habitat Regulations Assessment (Volume 5: Appendices)** (henceforth 'Statement to Inform HRA') appended to **Chapter 7: Terrestrial Ecology**, for the proposed Glen Earrach Pumped Storage Hydro (PSH) project (hereon referred to as the Proposed Development), a request for further information was made by NatureScot regarding Urquhart Bay Wood Special Area of Conservation (SAC).

1.1.2 This document responds to the Interim Response from NatureScot, dated 11 November 2025, where it was requested that details be provided of how much woodland will be inundated and for how long each inundation event will last above the current median summer level. As requested, the document is accompanied by a detailed fine scale map, which clearly shows the areas of woodland that would be inundated at different loch levels, together with current National Vegetation Classification (NVC) type, colour coded to show the areas with the highest impacts.

2. Methods

2.1.1 Further hydrological modelling analysis has been carried out to provide information on the durations of inundation events and other statistical information, resulting in the tabular data and graphs in Appendix A. Data are provided for each Predicted Water Area of increasing elevations (see next paragraph), and for different periods and different scenarios (the key scenario is that with the variable weir at the northern end of Loch Ness, which is required for matters not related to Urquhart Bay Wood SAC, and with all consented/proposed PSHs operating).

2.1.2 To better understand the spatial extents to which different water levels in Loch Ness may inundate the edge of the Urquhart Bay Wood SAC, a LiDAR[1] survey has been carried out to provide precise topographical levels (contours) at 0.2 m intervals. The LiDAR-derived levels start at the median summer level of Loch Ness (15.7 m, as stipulated by SEPA[2]) and continue in 0.2 m intervals up to 17.5 m. The area of the SAC between 15.7 m and a specified higher level above it is referred to as the Predicted Water Area for that specified higher level. Naturally, the Predicted Water Area is more extensive the higher the water level; however, a Predicted Water Area does not itself imply any frequency or duration of inundation, only the area predicted to be inundated if loch water levels reached the specified height.

2.1.3 Additional site visits were carried out in November 2025 and January/February 2026, with a focus on the north-eastern part of the SAC. Photographs, video footage and drone footage were recorded. Using a combination of ground flora observations and the LiDAR data, and noting that W7 woodland closely seen in summer 2024 appears to reasonably correlate with levels up to approximately 16.7-16.9 m, with W9 prevalent at higher levels, dominant NVC types have been assigned beyond those areas inspected in 2024. An accurate boundary for an area of open swamp within the north-eastern part of the SAC was also separated by inspecting aerial imagery as well as the drone recordings.

2.1.4 A further literature search was carried out for information on the flood tolerance of ground flora species associated with the woodland corresponding to NVC type W7. W7 dominates in the parts of the SAC beside and nearer Loch Ness, and is thus the woodland type that would be most often subject to inundation events[3]. Further investigation into how the growing season for this region should be best defined was also carried out.

[1] Light Detection and Ranging (LiDAR), a remote sensing technique that uses pulsed laser light to measure distances and create precise 3D models or maps of environments.
[2] This is slightly lower than the overall mean loch level of 15.82 m employed as the loch/SAC edge in the EIAR in Appendix 7.2: Statement to Inform Habitat Regulations Assessment (Volume 5: Appendices).
[3] NVC type W9, which occupies a large part of the SAC, dominates ground at higher elevations; as noted in the Statement to Inform HRA, there may be some conversion of W9 to W7 at the lowest elevations of W9, however since both NVC types constitute the qualifying Annex I alluvial alderwood at this SAC, this would not result in change in extent of qualifying habitat.

3. Updated Baseline SAC Information

3.1.1 A summary description of vegetation in the SAC is provided in the original **Appendix 7.2: Statement to Inform Habitat Regulations Assessment (Volume 5: Appendices)**. The qualifying habitat is alluvial alderwood on floodplains[4]. The Conservation Advice Package[5] notes that both NVC types W7 (a neutral wet woodland) and W9 (a basic dry woodland) (Rodwell, 1991) are present in the SAC and both are considered to constitute the qualifying alluvial woodland. Inspection of parts of the SAC near public footpaths in 2024 noted that the more low-lying parts near Loch Ness are predominantly W7, or in places transitional W7-W9, and elsewhere W9 predominates. The tree composition includes much alder *Alnus glutinosa* in the W7, whereas this is less common in the W9 (which is essentially a dry woodland type, and where other species such as ash *Fraxinus excelsior*, bird cherry *Prunus padus*, hazel *Corylus avellana* and often sycamore *Acer pseudoplatanus* are common).

3.1.2 The W7 seen closely in 2024 incorporates elements of both the W7a and W7b sub-communities. The canopy includes grey willow *Salix cinerea*, crack willow *Salix fragilis*, ash and sycamore in addition to alder. The ground flora includes neutral wetland indicators such as creeping buttercup *Ranunculus repens* (very abundant), soft-rush *Juncus effusus*, meadowsweet *Filipendula ulmaria*, tufted hair-grass *Deschampsia cespitosa*, angelica *Angelica sylvestris*, marsh marigold *Caltha palustris*, valerian *Valeriana officinalis* and reed canary-grass *Phalaris arundinacea*. There are also ruderal and non-native species including common nettle *Urtica dioica*, cleavers *Galium aparine*, ground elder *Aegopodium podagraria*, pick-a-back plant *Tolmiea menziesii*, Japanese knotweed *Reynoutria japonica* and Himalayan balsam *Impatiens glandulifera* (the last three all invasive non-native plants). Other recorded species include remote sedge *Carex remota,* wood sedge *Carex sylvatica*, bearded couch *Elytrigia canina*, giant fescue *Schedonorus giganteus,* hairy brome *Bromopsis ramosa*, woundwort *Stachys sylvatica* and Yorkshire-fog *Holcus lanatus*. There is a good range of epiphytic mosses and lichens, notably including the moss *Cryphaea heteromalla* (on crack willow, and rare this far north). Reed canary-grass is evidently particularly common in the north-eastern part of the SAC, which is the largest low-lying section (see Figure 1).

3.1.3 Some woodland in the central part of the SAC near Loch Ness was classed as intermediate between W7 and W9. This has a canopy of alder, ash, sycamore, grey willow, goat willow, crack willow, bird cherry, rowan *Sorbus aucuparia* and downy birch *Betula pubescens*. The ground flora is intermediate including great wood-rush *Luzula sylvatica*, dog's mercury *Mercurialis perennis*, tufted hair-grass, meadowsweet, lady-fern *Athyrium filix-femina*, marsh hawksbeard *Crepis paludosa*, creeping buttercup, woundwort *Stachys sylvatica*, water avens *Geum rivale*, figwort *Scrophularia nodosa*, red campion *Silene dioica*, intermediate enchanter's-nightshade *Circaea x intermedia*, wood speedwell *Veronica montana*, wood anemone *Anemone nemorosa*, Yorkshire fog, cleavers, reed canary-grass, soft-rush, Himalayan balsam, pick-a-back plant (locally dominant). Broad-leaved helleborine *Epipactis helleborine* (a very scarce plant in northern Scotland) was noted at Ordnance Survey grid reference NH 52477 29520.

3.1.4 The combined LiDAR levels overlaid with updated NVC information are shown on Figure 1. Square brackets indicate NVC types derived from information from site visits in late 2025 / February 2026, combined with LiDAR data in comparison to the W7/W9 inspected in summer 2024, and represent the NVC type considered to be dominant. Observations from the site visits in late 2025 / February 2026 in the W7 in the north-eastern part of the SAC include abundant creeping buttercup (similarly to W7 closely seen in summer 2024), frequent opposite-leaved golden-saxifrage *Chrysosplenium oppositifolium*, frequent to abundant reed canary-grass *Phalaris arundinacea* and tufted hair-grass, frequent soft-rush, occasional to frequent lesser celandine *Ficaria verna*, and occasional water avens and hemlock water-dropwort *Oenanthe crocata*. Occasional raised patches exist, including at the loch edge, supporting local greater woodrush and an unexpected single occurrence of juniper *Juniperus communis*. Other notable observations include the particular frequency of pooled water in the north-eastern part of the SAC, occasionally with brooklime *Veronica beccabunga*, and the occurrence at the loch edge and within approximately 5-10 m of it of patches of watery vegetation with bottle sedge *Carex rostrata* and water horsetail *Equisetum fluviatile*. Willows are present in addition to abundant alder, and notably a few alders were seen to be growing mangrove-like within the peripheral part of the loch and surrounded by water, despite the low water level for the time of year (15.5 m). Observations such as abundant reed canary-grass, frequent pooled water and occasional patches by or near the loch of bottle sedge vegetation indicate that W7 here is wetter than is often the case for W7. Drier woodland on higher ground further inland from this north-eastern wetter W7 exhibits an absence or infrequency of the above species and higher frequency of species of drier conditions (such as

[4] The Annex I code and full name is: 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
[5] https://sitelink.nature.scot/site/8406

great woodrush and dryopteroid ferns) and are suggestive instead of further extents of drier W9 (which dominates in the SAC beyond those areas dominated by W7).

3.1.5 Within the north-eastern part of the SAC, which contains the most low-lying ground, a non-wooded zone of S28 *Phalaris arundinacea* swamp has been indicated on Figure 1. This is separated in the NatureScot national NVC dataset[6] as 'S' (meaning swamp); however, that boundary appears now inaccurate and the indicated boundary has been derived by inspection of aerial imagery, whilst site visit in early February 2026 clearly indicated abundant reed canary-grass, as well as soft-rush. The change in position of this swamp since the NatureScot NVC dataset was produced may be due to previous error, but could equally be due to the dynamism of the woodland in this SAC, which incurs regularly alterations as a result of river action (mainly in winter, and a natural part of the alluvial woodland). This area was particularly waterlogged in the winter of 2025/2026, and pooled water was common in the surrounding wet woodland, which is where most of the Predicted Water Area of 15.9 m occurs and a larger part of the 16.1 m Predicted Water Area (see Figure 1).

3.1.6 A few alders at the loch edge in the north-east were noted to be separate from the woodland and growing isolated in the loch edge sediment. These were entirely surrounded by water in early February 2026 when water levels were quite low for the time year (15.5 m), but showing bud development, testament to the ability of alder to grow in extremely wet situations.

4. Durations of inundations

4.1.1 The EIAR and **Appendix 7.2: Statement to Inform Habitat Regulations Assessment (Volume 5: Appendices)** provided tabular data on inundation exceedances within the SAC at different heights. Exceedances are the percentage of a given period that the specified height (as determined by hydrological modelling) would be exceeded by inundations from Loch Ness, for a given scenario.

4.1.2 To provide requested detail on the durations of individual inundations, further analysis has been carried out. The graphs and tables provided in Appendix A demonstrate the findings. Separate data are provided for the growing season (regarding the length of which see below) and spring, summer, autumn and winter. The variable weir would be in operation from the start of May to the end of September, and the modelled outputs reflect this. Additionally, and for comparison, drying events have been analysed.

4.1.3 The below summary points relate to the key scenario with proposed seasonal variable weir and all consented/proposed PSHs operating (the Proposed Development, Loch na Cathrach, Loch Kemp and existing Foyers PSHs) where the seasonal variable weir is at the northern end of Loch Ness and required for reasons not related to Urquhart Bay Wood SAC. Each bullet point summarises information for the Predicted Water Areas shown on Figure 1:

- 15.7 m – this Predicted Water Area is a very narrow zone at the edge of the SAC / loch, representing 0.3% of the SAC. Being the lowest zone, it inundates the most – for the growing season, the exceedance is 86.6%, however baseline is also high at 70.7%. The majority of inundation events (35.4, 68%) are of 24 hours or less duration, and most frequent below 13 hours. For comparison, there would be on average 46.1 drying events of 24 hours or less duration, and 5 of longer duration. The median inundation duration is 11 hours, which is considerably less than baseline (40 hours) – this is owing to more fluctuation with the PSHs operating, thus less sustained inundation periods;
- 15.9 m – this Predicted Water Area occupies 2.6% of the SAC. For the growing season, the exceedance is 63.9% (14.2% at baseline), i.e. roughly one quarter (26.1%) of the time not inundated to this height. The majority of inundation events (59, 74%) are of 24 hours or less duration, and most frequent below 13 hours. There would be on average 11.1 inundations of 1-3 days duration, 7.2 of 3-7 days, and 2.8 exceeding one week. For comparison, there would be on average 67.4 drying events of 24 hours or less duration, and 12.4 of longer duration including 1.8 of longer than one week. The median inundation duration is 10 hours, which is considerably less than baseline (25 hours) – this is owing to more fluctuation with the PSHs operating, thus less sustained inundation periods;
- 16.1 m – this Predicted Water Area occupies 5.0% of the SAC. For the growing season, the exceedance is 40.3% (1.8% at baseline), i.e. well over half (59.7%) of the time not inundated to this height. The majority of inundation events (54, 78%) are of 24 hours or less duration. There would be on average 7.0 inundations of 1-3 days duration, 6.0 of 3-7 days, and 1.9 exceeding one week. For

[6] https://opendata.nature.scot/

comparison, there would be on average 51.4 drying events of 24 hours or less duration, and 12.4 of longer duration including 1.8 of longer than one week. The median inundation duration is 8 hours, which is considerably less than baseline (41 hours) – this is owing to more fluctuation with the PSHs operating, thus less sustained inundation periods;

- 16.3 m – this Predicted Water Area occupies 4.2% of the SAC. For the growing season, the exceedance is 22.6% (0.3% at baseline), i.e. roughly three-quarters (77.4%) of the time not inundated to this height. The majority of inundation events (37.8, 79%) are of 24 hours or less duration. There would be on average 6.0 inundations of 1-3 days duration, 2.8 of 3-7 days, and 1.1 exceeding one week. For comparison, there would be on average 32.7 drying events of 24 hours or less duration, and 16 of longer duration including 3.9 of longer than one week. The median inundation duration is 9 hours, which is less than baseline (15 hours) – this is owing to more fluctuation with the PSHs operating, thus less sustained inundation periods;
- 16.5 m - this Predicted Water Area occupies 4.1% of the SAC. For the growing season, the exceedance is 10.4% (0.1% at baseline), i.e. most of the time (89.6%) not inundated to this height. The majority of inundation events (22.7, 83%) are of 24 hours or less duration. There would be on average 3.7 inundations of 1-3 days duration, 1.0 of 3-7 days, and 0.1 exceeding one week. For comparison, there would be on average 19.0 drying events of 24 hours or less duration, and 9.8 of longer duration including 4.7 of longer than one week. The median inundation duration is 9 hours, which is less than baseline (55 hours) – this is owing to more fluctuation with the PSHs operating, thus less sustained inundation periods;
- Above 16.5 m – as can be seen from the tables in Appendix A, the inundation impacts are increasingly slight from 16.5 m upwards.

4.1.4 Note that while in all cases summarised in the above bullet points the median inundation period is less than at baseline owing to more fluctuation with the PSHs operating, this does not imply very rapid fluctuation – water level would change in the order of centimetres per hour.

5. Further literature search information

5.1 Definition of growing season

5.1.1 The growing season is of particular importance since this is when plants are most susceptible to flooding, as highlighted in the alder studies cited in the original Statement to Inform HRA, and also in some of the studies concerned with ground flora species cited below. Further investigation into the best way to define the growing season for the region of this SAC has been carried out, so that hydrological modelling could also be undertaken specifically for the growing season. Korner et al. (2023) states that the start of the growing season for temperate forests is commonly defined as the sustained passing of a 5°C daily mean at the beginning of the season (3–10 days in a row, mostly five days), and the end the first days with daily means below 5°C (for e.g. 10 days). Closely matching this is the definition provided in the UK for central England (but the principle of which should be applicable more widely) in Department of Energy & Climate Change (2013), stating that the thermal growing season as the longest period within a year for which the start is a period of five successive days with daily-average temperature above 5°C, and the end the day before a period of five successive days with daily-average temperature below 5°C. Mis & Tomczyk (2025) has a similar definition but using six continuous days rather than five.

5.1.2 The UK definition in the previous paragraph has been employed here. Daily average temperatures for the last five years (2020 to 2025, inclusive), with Inverness as the closest available location, were downloaded from https://meteostat.net/en/place/gb/inverness?s=03059&t=2026-01-22/2026-01-29 (accessed 05/02/2026). Analysis of this data indicates that October should certainly be included within the growing period, with all five years showing more or less continuous average daily temperatures above 5°C in October. Depending on the particular year, several ‘growing’ periods did occur in March and November and sometimes briefly even in December, January and February. However, for the last five years the above UK growing season criteria are met most consistently across the period April to October, inclusive, which has therefore been taken as the growing season.

5.2 Flooding tolerance of species other than alder

5.2.1 There does not appear to be abundant information on the flooding tolerance of ground flora species that occur in the W7 wet woodland at the SAC. However, the following useful information has been found:

- Banach et al. (2009) – a study using material from south-east Poland, with two relevant species – tufted hair-grass and Yorkshire-fog. No Yorkshire-fog survived after three weeks of continuous flooding. However, tufted hair-grass survived with no mortality after 6 weeks of continuous flooding (considerably longer than the durations of most inundations at the SAC induced by the combined PSHs), followed by two weeks recovery, and produced sufficient biomass in the recovery period to indicate that growth continued during flooding, or commenced soon thereafter;
- Brotherton et al. (2018) – a study from the UK with one species of relevance – cuckooflower *Cardamine pratensis*, which has not been noted in the W7 in the SAC but is a species that can occur in W7 (Rodwell, 1991) and is probably locally present, and may be representative of smaller herbs of damp habitats that are not particularly flood-adapted. In this study, cuckooflower survived repeated 7-day inundations (the flood height above substrate was however only 7 cm, so plants could extend above the water);
- Campbell et al. (2016) – an American study that included one relevant species, soft-rush, which was determined in this study to tolerate a maximum of 67% of the growing season under flood (note that exceedance for the growing season for the full in-combination scenario is 63.9%). It does not appear clear what the flood depths were, however induced flooding was cyclic with flood levels rising and falling three times across the growing season (taken as April to October, inclusive) such that plants at the lowest levels were constantly under flood, and flooded for less of the growing season at increasing heights within the experimental area;
- In Barsoum et al. (2005) and Studer-Ehrensberger et al. (1993) information is given for one key species present in W7 in the SAC, meadowsweet, and in the former study also for willows which although not ground flora species do also occur in the W7 at the SAC and are therefore also mentioned here:
- meadowsweet – noted to be among the more anoxia-tolerant temperate herbs that can tolerate extended waterlogged conditions. Young plants of 11-12 weeks age showed marked reductions in survival/growth after extremely long continuous flooding of 200 days (a duration that does not occur in the hydrological modelling); in another experiment, no adverse effect was found on rhizomes kept in fully anaerobic conditions for two weeks continuously, which resumed shoot growth upon the water table subsiding;
- grey willow *Salix cinerea* and goat willow *Salix caprea* – 13 weeks of waterlogging had little effect. Where roots died, new roots grew vertically to the water surface. This correlates with the known occurrence of grey willow in very wet conditions, and is of more note for goat willow which typically does not occur in very wet conditions but is able, judging from this, to survive them. These willows occur in the W7 at the SAC including in the lowest-lying north-eastern part;
- Johansson & Nilsson (2002) – a Swedish study into the effect of flooding in real world locations, in which one species is relevant, again meadowsweet. This study is of particular note because it included investigations of two run-of-river impoundments where flooding occurred more or less daily for the whole study, and in which transplanted meadowsweet plants did not exhibit mortality until reaching approximately 280-300 flooded days across the study period of 14 months; not all meadowsweet plants succumbed even at this exceedance;
- Brix & Sorrel (1996) – an experiment with two species including one that is relevant, reed canary-grass, which is abundant in the lower-lying parts of the SAC including the north-eastern part. This demonstrated that deoxygenating the roots of reed canary-grass resulted in little if any oxygen stress even when pre-adapted to aerated conditions. This is not entirely surprising, given that reed canary-grass can occur in standing water. In support of this type of experimental method, Fagerstedt & Crawford (1987) demonstrated that anoxia tolerance was positively correlated with flooding tolerance.

5.2.2 Within Barsoum et al. (2005) there is a brief statement under the section regarding flooding for alluvial alderwood of a ‘rule of thumb’ limit of 40% of the growing season under flood, for which two references are cited. Confusingly, however, one of these references (Kozlowksi, 1984), is an American article concerned with plant physiology and referring to plants that do not occur in the UK, in which there appears to be no mention of 40% of the growing season of any habitat. Unfortunately, it has not been possible to obtain the other cited reference (Crawford, 1982),

which is not available to purchase for online viewing, but it is noted that this article is part of an encyclopedia of plant physiology rather ecohydrology of habitats, the same theme as Kozlowksi (1984). However, as discussed below, even if making use of this rule of thumb, the growing season only fractionally exceeds 40% (40.3%) at 16.1 m with the seasonal variable weir and all consented/proposed PSHs, suggesting that the two lower Predicted Water Areas of 15.9 m and 15.7 m are more critical, and for which consideration has been given in the following Section of existing flora, the tolerance of certain species to flooding and inundation modelling.

6. Discussion

6.1.1 It has not been possible to verify the reasoning for the suggested 40% limit in Barsoum et al. (2005) for exceedance during the growing season in alluvial alderwood, as noted in Section 5. Nevertheless, and notwithstanding that this is given only as a rule of thumb, 40% of the growing season under flood is only fractionally exceeded (40.3%) at 16.1 m, for the full in-combination scenario with the proposed seasonal variable weir. At 16.1 m for the growing season, most (78%) of inundation events are less than 24 hours in duration with on average of 1.9 inundations during this period exceeding one week, and a similar number of drying events including 1.8 of over one week. In view also of the literature information above on flood tolerance of W7 species such as meadowsweet, tufted hair-grass and reed canary-grass. It is not considered likely that radical ground flora change would occur in the 16.1 m Predicted Water Area, and by extension no significant change at higher levels.

6.1.2 Areas below 16.1 m are therefore most critical, in particular the 15.9 m and 15.7 m Predicted Water Areas. By far the largest extent of SAC ground in the 15.9 m Predicted Water Area is in the north-eastern part of the SAC (the greater part of the 16.1 m Predicted Water Area is also found here – see Figure 1). Important points about this area are that it is wetter than other W7, the clearer signs of this including abundant reed canary-grass and locally towards and at the loch edge the occurrence of patches of bottle sedge, often with water horsetail, as well as the presence of much pooled water at least in the winter. As such, the W7 here is at the wetter end of the continuum of vegetation variation associated with W7. Bottle sedge in the ground flora is in particular not characteristic of W7.

6.1.3 In the 15.7 m Predicted Water Area, inundation exceedance for the growing season is by far the highest at 86.6%, however it is important to note that baseline exceedance is already high at this low level at 70.7%. It is also the case that median inundation duration would actually decrease to about a quarter of baseline median duration under the full in-combination scenario, owing to the effect of the PSHs operating, with each inundation period on average less sustained than at baseline (this is common to all Predicted Water Areas, but most significant at this lowest level of the SAC). Given the existing baseline high exceedance level, it does not appear likely that change in ground flora could be severe. Given also that mature budding alders were observed in February 2026 at the loch edge here fully surrounded by loch water at a low level of 15.5 m (below median summer level) it would also appear unlikely that alder distribution would radically change here. It is also important to note that the 15.7 m Predicted Water Area is peripheral and occupies an extremely small proportion of the SAC, at 0.3%.

6.1.4 With increased inundation, bottle sedge in the ground flora would likely increase in the 15.9 m Predicted Water Areas. However, as noted some patches of such baseline vegetation already exist within the W7 woodland close to Loch Ness, and this would remain on alluvial substrate with alder prominent (see **Appendix 7.2: Statement to Inform Habitat Regulations Assessment (Volume 5: Appendices)** for literature information as to the flooding tolerance of alder, suggesting that it would very likely be able to tolerate more than the exceedance for the growing season at 15.9 m, a point supported by the aforementioned observation in February 2026 of some growing alders fully surrounded by loch water at a level of 15.5 m). Information on the flood tolerance of relevant ground flora appears rather limited. However, considering the above literature information in Section 5, and the modelling data indicating that 74% of inundations at 15.9 m would be of 24 hours or less duration and the median duration 10 hours, this suggests that some wetland species present in the SAC W7 within the 15.9 m Predicted Water Area would persist, such as tufted hair-grass, meadowsweet and soft-rush. Reed canary-grass, currently abundant in the north-eastern part of the SAC, can sometimes occur in standing water and would therefore be unlikely to decrease and more likely to increase. Small herbs and grasses that are common in the current W7 that would likely not be able to tolerate prolonged inundation, such as Yorkshire-fog, creeping buttercup and opposite-leaved golden-saxifrage, would likely decrease significantly or become largely absent in the 15.9 m Predicted Water Area. However, since the aforementioned existing tufted hair-grass, meadowsweet, soft-rush and reed canary-grass appear likely to persist, vegetation in the 15.9 m Predicted Water Area would likely at least in part retain affinities with W7. Additionally, the substrate would remain alluvial, alluvial deposition by river action (which primarily occurs in winter when the seasonal variable weir would not be operating) would continue to occasionally occur, and alder would remain prominent, in common with the Annex I alluvial alderwood as a whole.

6.1.5 Alluvial deposition by river action (which can be significant in winter) would continue to occur also in the higher Predicted Water Areas. As noted previously, the rate of change of water level will be in the order of centimetres per hour and therefore not likely to cause significant erosion risk. With regard to channel dynamics in general, these processes are primarily driven by river flows and associated fluvial sediment dynamics rather than loch water level variation, thus it is not considered likely that there would be substantive change to channel form or behaviour as a consequence of the proposed operational water level regime. It is also important to note that the baseline maximum and minimum levels of the loch will not be exceeded, and that in the non-operating period of the weir there will be slight reductions in inundation exceedances at 15.7 m and to lesser degree at 15.9 m (see Appendix A).

6.1.6 The Joint Nature Conservation Committee (JNCC) note that Annex I 91E0 is best maintained within a larger unit that includes open communities such as fen and swamp, and that the ground flora can be varied, including some stands dominated by reeds and sedges. The integrity of an Annex I habitat under the Habitats Regulations is not assessed against a fixed or static species composition, but rather the ability of the habitat to maintain its essential structure, functions and processes, and to support the characteristic species and ecological conditions that define it. For alluvial alderwood, the defining characteristics are the persistence of alder-dominated woodland on alluvial substrate subject to periodic inundation, with associated wetland flora and continuing fluvial processes. These defining characteristics are process-driven: alluvial deposition, periodic flooding and the dynamic relationship between woodland and water system are fundamental properties of the habitat type. The predicted changes in ground flora composition, particularly within the 15.9 m Predicted Water Area, with a shift in abundance amongst existing species likely favouring species such as reed canary-grass (already abundant in the north-eastern and most extensively low-lying part of the SAC), tufted hair-grass, meadowsweet and soft-rush, and a probable reduction in this area of less flood-tolerant herbs, is not inconsistent with the wetter end of floristic variation of Annex I 91E0 alluvial woodland, rather than a full departure from it. The lowest-lying existing Annex I 91E0 woodland habitat at this SAC (most extensively in the north-east) already exhibits a wet expression of W7, with abundant reed canary-grass and local patches of bottle sedge vegetation near the loch, and pooled water common especially in winter. A further floristic shift in this direction, within a peripheral and small proportion of the SAC, with likely retained affinities with W7, continued fluvial processes (including alluvial deposition) and no likely appreciable change in alder distribution, is not considered to fundamentally alter the alluvial woodland system and to remain Annex I 91E0 alluvial alderwood.

7. Conclusion

7.1.1 The above further information and discussion suggest (for the full in-combination scenario with all PSHs and proposed seasonal variable weir) that a shift in ground flora composition towards wetter adapted species is most likely to occur in the 15.9 m Predicted Water Area. However, whilst small wetland herbs and grasses such as Yorkshire fog, creeping buttercup and opposite-leaved golden-saxifrage are likely to decline , and reed canary-grass (already abundant) and bottle sedge will likely increase particularly in the 15.9 m Predicted Water Area, other plant species associated with the existing W7 at this level are likely to persist, such as tufted hair-grass, meadowsweet and soft-rush, such that vegetation in the 15.9 m Predicted Water Area is considered likely to retain affinities with W7. Additionally, the substrate would remain alluvial, alluvial deposition by the rivers would still occur (primarily in winter) and the distribution of alder is unlikely to change appreciably (especially supported by the observation of some alders growing surrounded by loch water at 15.5 m). Change is likely to be less significant in the 16.1 m Predicted Water Area, and progressively less still at higher elevations.

7.1.2 As previously noted, it is possible that the lowest parts of the W9 woodland may transition towards W7, however this does not change the extent of Annex I alluvial alderwood, since both are considered to constitute the Annex I habitat at this SAC.

7.1.3 Consequently, it is considered that there will not be an adverse effect on the integrity of Urquhart Bay Wood SAC as a result of the Proposed Development, either alone or in-combination with other consented and proposed pumped hydro storage schemes.

8. References

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Appendix A

Please refer to separate digital documents:

- GEE AI TA A1 – to GEE AI TA A10