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# THIRLMERE ABSTRACTION LICENCES

## ENVIRONMENTAL REPORT TO SUPPORT LICENCE RENEWALS

Report for United Utilities Water Limited

Report for United Utilities Water Limited -
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Front cover image: Thirlmere from Rough Crag 

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# EXECUTIVE SUMMARY

This report has been prepared to support the like-for-like renewal of the Thirlmere abstraction licences. These licences are the main Thirlmere abstraction licence (No.27 75 009 011) and the eight transfer licences from tributaries (Helvellyn Gill, tributaries of Howe Beck, Fisherplace Gill, Sty Beck / Stannah Gill, Ladknott Gill, Mill Gill, Black Gill and tributaries of St John's Beck. It has also been prepared to support consultation with Natural England on the cessation of the existing voluntary level based flood drawdown operating regime at Thirlmere.

The Thirlmere abstraction licence was amended to allow the abstraction and transfer of water to supply United Utilities' former West Cumbria water resource zone via a pipeline known as the Thirlmere Transfer Scheme. The daily and annual licence volumes were not changed, but the proportion of the daily licenced volume that could be abstracted at Bridge End (the northern abstraction point) was increased to allow the transfer to West Cumbria. A statutory Environmental Impact Assessment and Habitats Regulations Assessment were completed in 2016 in support of the Planning Application for the Thirlmere Transfer Scheme and included an assessment of the licence change to the operating regime and spill regime of Thirlmere. In accordance with the Habitats Regulations, an in-combination assessment with the level based flood drawdown releases that have been made from Thirlmere since approximately 2008, in voluntary agreement between United Utilities and the Keswick Flood Action Group.

To mitigate for impacts to the downstream watercourse, St Johns Beck (part of the River Derwent and Bassenthwaite Lake Special Area of Conservation), due to loss of Thirlmere spill events due to the impacts of both the Thirlmere Transfer Scheme and flood drawdown releases acting in-combination, an agreement under Section 20 of the Water Resources Act 1991 was developed. This is referred to as the Mitigation Section 20 and included a schedule of mitigation releases and implementation of catchment interventions to improve sediment transport and habitat for Special Area of Conservation species, delivered through the funding of a five year project officer role hosted by West Cumbria Rivers Trust. There are two other Section 20 agreements dated 2015 which were agreed following the Environment Agency Review of Consents relating to fisheries waterbank arrangements and a sediment management plan.

The previous environmental assessment undertaken in support of the planning application and the update to this assessment undertaken in 2020 during Section 20 development indicated that a large proportion of the 'lost' Thirlmere spill events were due to the operation of the voluntary reservoir level based flood drawdown operating regime. This report comprises an update to the hydrological assessments, using United Utilities' most recent water resources modelling.

United Utilities has confirmed that the current reservoir level based voluntary flood drawdown operating regime releases will be ceased, effective from the date of renewal of the Thirlmere licences, with the aim to replace this with a forecast driven approach to flood releases. United Utilities is committed to working together with the Environment Agency to develop a future forecast driven operating regime of

releases for Thirlmere. This regime will be developed following the completion of Environment Agency flood modelling. When agreed in the future, this regime should be assessed appropriately under the Habitats Regulations in-combination with the nine Thirlmere abstraction licences and any other relevant plans or projects.

Therefore, the reservoir level based flood drawdown releases are included in the 'baseline' of the assessment presented in this report (as they happen now), but not in the 'assessment' scenario or as an in-combination impact as they will be ceased. Ceasing reservoir level based flood drawdown releases significantly increases the spill regime from the reservoir towards the 'reference' scenario of no reservoir level based flood drawdown and no Thirlmere Transfer Scheme operation.

Mitigation releases for the impacts of the Thirlmere Transfer Scheme alone have been proposed in this report. Two annual Autumn Large Spate releases similar to those undertaken under the Mitigation Section 20 are proposed. This could be incorporated into a renewed Mitigation Section 20 agreement going forward. The mitigation releases also include amendment to the use of the existing fisheries water bank Section 20 agreement to include for spring releases to aid smolt migration. The Section 20 sediment management arrangements and the fisheries water bank Section 20 should both be retained and reviewed annually.

For the Thirlmere abstraction licence. it is concluded from the assessment presented in this report, that there will be no likely significant effects, either alone or in combination, on the Conservation Objectives or the qualifying features of the River Derwent and Bassenthwaite Special Area of Conservation and thus no significant adverse effect on the site integrity of the Special Area of Conservation as it is assessed that the licence renewal would bring the flows more in line with the reference scenario.

For the eight tributary transfer licences, the impacts of the eight transfers identified in the 2006 Environment Agency Review of Consents report are mitigated by the implementation of a prescribed flow at Howe Beck, the migration flows and the sediment management plan which were specified in the 2009 Environment Agency Site Action Plan. These measures are working effectively which is demonstrated by the improved numbers of fish in the Howe Beck watercourse in the Environment Agency and West Cumbria Rivers Trust monitoring data from the period 2010 to 2024. The success of these management action in the benefit to the salmonid populations of Howe Beck/Helvellyn Gill is documented in the Environment Agency's Restoring Sustainable Abstraction (RSA) report[1]. In addition, since the RSA study reported, significant habitat, sediment mobilisation and fish passage improvements have been made in Howe Beck by the West Cumbria Rivers Trust St Johns Beck Site Officer. This is above and beyond the actions recommended in the 2009 Site Action Plan.

It is therefore concluded that mitigation measures for the eight transfer licences are in place and have been demonstrated to be effective and there are No Likely Significant Effects on site integrity of any of the eight transfer licences.

[1] EA (2020) Restoring Sustainable Abstraction 10 year monitoring programme. Draft final report March 2020.

This report has been prepared to fulfil two purposes:

1. Support the application for like for like renewal of the nine Thirlmere abstraction licences. The Environment Agency is the competent authority under the Habitats Regulations for the abstraction licence renewals and have a duty to consult with Natural England.

2. Provide an assessment under the Habitats Regulations of cessation of the reservoir level based flood drawdown releases that have been made from Thirlmere since approximately 2008, in voluntary agreement between United Utilities and the Keswick Flood Action Group. United Utilities is the competent authority under the Habitats Regulations for the flood drawdown regime and have a duty to consult with Natural England when ceasing the release regime.

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# 1 INTRODUCTION

United Utilities Water Limited (UU) have contracted Ricardo to undertake an environmental assessment and HRA (Habitats Regulations Assessment) to support the like for like renewal of the Thirlmere licences. These are the Abstraction Licences, including the main Thirlmere abstraction licence (No. 27 75 009 011) and the eight transfer licences from tributaries (Helvellyn Gill, tributaries of Howe Beck, Fisherplace Gill, Sty Beck / Stannah Gill, Ladknott Gill, Mill Gill, Black Gill and tributaries of St John's Beck. The application is to retain all the Thirlmere licences on a like for like basis. This includes, in the Thirlmere licence, the maximum abstraction rates at the values listed in Sections 6.1 through 6.4, which otherwise revert to the values in Section 6.5 through 6.8 from 1 April 2026.

There are currently three agreements under Section 20 of the Water Resources Act 1991 relating to the Thirlmere licences: a sediment management agreement (dated 10 November 2015), a fisheries releases agreement (dated 10 November 2015) and a mitigation agreement relating to the main Thirlmere licence and the flood releases (dated 22 July 2022). The later agreement expires on 31 March 2026 in line with the expiration of the time limited element of the Thirlmere abstraction licence.

It is important to note that the effects of Thirlmere and the Mill Gill Aqueduct on adult Atlantic salmon migration cues within St Johns Beck and Howe Beck are appropriately mitigated by the Section 20 Agreement *Operation of water releases from Thirlmere Reservoir and from Mill Gill Aqueduct for the benefit of fish migration* (2015). UU are not seeking to vary the conditions of this Section 20 agreement. This Section 20 agreement does not have an expiry date. For the purposes of this licence renewal application this Section 20 agreement is considered to remain in place.

It is important to note that UU have confirmed they will cease the current voluntary agreement with the Keswick Flood Action Group to make reservoir level based flood drawdown (FDD) releases from Thirlmere[2].

This report has been prepared to support the licence renewals, and also provides recommendations of suitable flow release regimes to mitigate for any residual impacts of abstraction on SAC designated features, to potentially supplement those included in the *Important Notes* in the *Additional Information* section of the main Thirlmere abstraction licence.

The assessment considers historical, current, and hypothetical flow regimes and their potential to meet various flow conditions relating to aquatic ecology and is not intended to be used as a basis for assessing flood risk or for any other purpose.

2 This is as listed in Appendix 1 of the Agreement under Section 20 of the Water Resources Act 1991 between United Utilities Water and the Environment Agency pertaining to Provision of mitigation measures in relation to Thirlmere Reservoir for the protection of the River Derwent and Bassenthwaite Lake Special Area of Conservation dated 22nd July 2021.

The remaining sections of this introduction briefly set out the background (**Section 1.1**), including the range of achievable managed releases from Thirlmere (**Section 1.2**) and presents the aims and structure of the environmental report (**Section 1.3**).

## 1.1 Background

Thirlmere, in the catchment of the River Derwent, is an impounding reservoir located ~5 km South East of Keswick, Cumbria, and is owned and operated by UU. The reservoir is part of UU's integrated supply network (known as the Strategic Zone). The Thirlmere abstraction licence was amended to allow the abstraction and transfer of water to supply UU's former West Cumbria water resource zone via a pipeline known as the Thirlmere Transfer Scheme (TTS). The TTS was the solution implemented to balance the water supply lost through the revocation of UU's licence to abstract from Ennerdale Water and the compensatory measures agreed with the Environment Agency and Natural England to compensate for the damage caused to the River Ehen SAC caused by abstraction from Ennerdale Water and a potential drought permit. Revocation of abstraction licences at Crummock Water, Overwater and Chapelhouse Reservoir were also part of the package of compensatory measures. These four abstraction licences were revoked in 2023.

A series of environmental assessments were undertaken to support the feasibility and implementation of the TTS and to identify the mitigation for inclusion in the Section 20 agreement for the TTS. In 2016, a HRA of the West Cumbria Transfer Scheme (TTS and FDD in combination) was conducted which included an Information to Inform the Appropriate Assessment (IIAA) appendix[3], as part of the statutory Environmental Impact Assessment (EIA) for the scheme and submitted in support of the application for Planning Permission. The hydrological screening process undertaken as part of the EIA highlighted that the change in hydrological regime as a result of the TTS would be potentially significant for Thirlmere and St. John's Beck (part of the River Derwent and Bassenthwaite Lake SAC), due to the changes in abstraction regime in Thirlmere.

Against a No Likely Significant Effect Baseline scenario that assumed that neither the FDD releases, or TTS were operational, the IIAA found that, due to effects on reservoir storage amending the reservoir spill characteristics, there would be a reduction in the frequency and magnitude of high flows and the frequency of moderate flows from the reservoir into St. John's Beck as a result of the TTS and FDD actioning in-combination. The reduction in frequency and magnitude of high flow events could reduce the already low ingress of gravels, pebbles and finer materials into the channel through the erosion of the river banks and bed. There would also be a reduction in flows that provide a 'cleansing' function to the rivers coarse sediment and could lead to increased build-up of fine sediment. It was concluded that the TTS and FDD, unmitigated, would have a significant adverse effect on the qualifying habitat within the River Derwent and Bassenthwaite Lake SAC. This assessment was updated in 2020 with more recent water resources modelling[4] which did not change the overall in-combination conclusions of the

3 West Cumbria Water Supplies Project – Thirlmere Transfer , Environmental Statement Volume 4 – Technical Appendices, Appendix 11.13 – Information to Inform the Appropriate Assessment (Habitat Regulations Assessment Stage 2) 17 March 2016. Prepared by Ricardo
4 Thirlmere Transfer Scheme: Briefing Note: Hydrological Assessment of St. John's Beck, December 2020. Prepared by Ricardo

2016 IIAA. However, when the Thirlmere Transfer Scheme was considered alone, the updated modelling indicated there would be a reduced impact on the spill regime of Thirlmere than was concluded in 2016 assessment. The 2020 update concluded that the main driver to the reduction in frequency and magnitude of high flows in St. John's Beck is the flood drawdown releases.

A Section 20 Agreement (2021) was developed which set out the requirement for mitigating the in-combination impacts of the TTS and FDD. To identify suitable mitigation for the TTS to be included in the Section 20 Agreement, APEM, on behalf of UU, undertook an investigation looking into the relationship between flows in St. John's Beck and the geomorphological processes that those flows deliver[5].

Following the development of the Section 20 Agreement, the list of managed releases that are currently made by UU from Thirlmere as stated in the abstraction licence, fisheries releases Section 20 Agreement (2015), notes to the abstraction licence and the mitigation Section 20 Agreement (2021) are:

- The compensation flow requirement from Thirlmere and the Mill Gill Aqueduct is 13.64 Ml/d (as specified in the abstraction licence). 3.0 Ml/d of this is delivered from the Mill Gill Aqueduct to Howe Beck, and 10.36 Ml/d from Thirlmere. When The Mill Gill Aqueduct is unable to sustain its portion of the compensation flow, the shortfall is made up from Thirlmere.
- Waterbank releases, subject of the fisheries releases Section 20 agreement (2015), with the objective to ensure that appropriate flows are available frequently enough to enable (i) adult salmon and trout to migrate into St John's Beck and from Mill Gill and Howe Beck to spawn and (ii) for smolts to migrate downstream:
    - 973 Ml/y from Thirlmere Reservoir to St John's Beck following a schedule developed annually by the Environment Agency and UU. The guide set out in Schedule 3 of the Section 20 Agreement (2015) is for releases from Thirlmere Releases to be made during the period late October to mid-December; and in Schedule 9 of the Section 20 Agreement (2015) as a two-day release at an interval of every other week; at a rate of 100 Ml/d in addition to the compensation flow (i.e. total 1.31 $m^3/s$); and timed with rainfall and with releases from the Mill Gill Aqueduct to Howe Beck to maximise their effectiveness.
    - Into Howe Beck by opening of the Mill Gill Aqueduct large penstock (50 Ml/d or 0.58 $m^3/s$) for a period of eight weeks starting in the 3rd week of October each year (excluding weekends and bank holidays) as set out in Schedule 10 of the Section 20 Agreement (2015).
- An annual Large Spate Flow mitigation release or releases of 560 Ml/d between the month of September and mid-November for a total of at least 6 hours, with best endeavours to increase this to at least 750 Ml/d.

5 APEM (2024) Thirlmere Release scenarios. Report for United Utilities, APEM Ref P00005090.

- A Small Flood Flow mitigation release (sufficient to provide the functions of a Small Flood Flow as set out in the UKTAG guidance on the flow building blocks to a river flow regime with Good Ecological Potential[6]) between September and the following February (Small Flood Flow discharge period) providing a flow of this magnitude has not been achieved in the 2 years prior to the start of the Small Flood Flow discharge period. The magnitude of flow in St. John's Beck for achieving this function is assumed as 1,750 Ml/d based on the current condition of the river and available monitoring data.
- The reservoir is also used for local flood risk management purposes in voluntary agreement between United Utilities and the Keswick Flood Action Group. For this FDD, UU currently release approximately 120 Ml/d[7] to St. John's Beck from Thirlmere when reservoir levels are between 0.5-3.0 m below spillway crest level, depending on the month. The aim of the FDD is to provide flood storage in Thirlmere, primarily to delay the flood peak down St John's Beck into the River Greta (the river downstream of St. John's Beck that flows through Keswick).

This combination of releases are considered as the baseline scenario releases in this assessment. The compliance point for measuring outflows from Thirlmere is the St. John's Beck at Thirlmere flow gauge NRFA no 75001. There is a separate compliance point on the Mill Gill Aqueduct for flows delivered to Howe Beck. Noting the catchment area to Thirlmere includes the drainage catchment to Thirlmere and the catchment intercepted by the Mill Gill Aqueduct (including Helvellyn Gill), the assessment throughout this report uses modelled data indicative of flow in St John's Beck at the Mill Gill confluence at NGR: NY317206. A separate Modelling Report has been included as Appendix 1 of this Environmental Report to document the model suitability.

[redacted]

The magnitude of the Small Flood Flow release has been specified by the Environment Agency and Natural England as 1,750 Ml/d. Controlled releases of this magnitude from Thirlmere are not possible with the current infrastructure and would require significant investment to construct new release mechanisms or to refurbish existing assets (**Section 1.2**). Currently the only feasible way of facilitating an increased frequency of larger flows down St John's Beck is to allow Thirlmere to spill. The nature of the FDD releases from the reservoir reduces the frequency of natural Small Flood Flow events as the regularity and magnitude of reservoir spill events is reduced by the FDD release of water to draw down the reservoir.

Along with these flow requirements, through the Mitigation Section 20 Agreement (2021), UU are also required, with the support of the Habitat Improvement Steering Group, to develop and deliver a Habitat

6 *cf.* Appendix 6: Background to suggested good ecological potential flow criteria in UKTAG (2013) River flow for good ecological potential Final recommendations
7 Ml/d – Million litres per 24 hour period

Improvement Action Plan to enhance, restore, or assist the recovery of the natural geomorphological processes in St. John's Beck. UU are funding a Site Officer hosted by West Cumbria Rivers Trust for a period of five years. The Site Officer commenced in post in September 2021 and has made excellent progress at delivering catchment interventions and habitat restoration in the St John's Beck valley. Progress is detailed in the annual reports which are submitted to the Environment Agency and Natural England at the end of February each year. The site officer is funded until September 2026.

The Mitigation Section 20 Agreement (2021) is designed to mitigate for the two 'projects' under the Habitats Regulations: the operation of the Thirlmere abstraction and the FDD operation. The former is UU's statutory duty as a Water Undertaker. The FDD release regime is a voluntary agreement and there is no legal or regulatory requirement for UU to continue to make releases for the purposes of flood mitigation, and therefore, because delivery of the mitigation flows required is infeasible, UU will cease the operation of the FDD going forward to reduce the impact of UU's operations on St John's Beck, therefore, reducing the impact requiring mitigation; i.e. mitigation at source.

## 1.2 Achievable Managed Releases from Thirlmere

As referenced in **Section 1.1**, managed releases from Thirlmere are currently limited in magnitude by the infrastructure and Bridge End water treatment works (WTW) offtake arrangements at the dam. The achievable releases from Thirlmere have been reviewed through a hydraulic modelling study by UU with the outcomes presented in **Figure 1-1**. [redacted]

## 1.3 Aim and structure of report

This report has been prepared to provide the environmental assessment and HRA for the like for like renewal of the Thirlmere abstraction licences, including the cessation of the FDD releases from Thirlmere. The linked licences relevant to this assessment comprise:

1) Thirlmere Reservoir ..... licence no. 27 75 009 011
2) Helvellyn Gill ..... licence no. NW/075/0009/004
3) Tributaries of Howe Beck [Helvellyn Gil][8] ..... licence no. NW/075/0009/005
4) Fisherplace Gill ..... licence no. NW/075/0009/006
5) Sty Beck / Stannah Gill ..... licence no. NW/075/0009/007
6) Ladknott Gill ..... licence no. NW/075/0009/008
7) Mill Gill ..... licence no. NW/075/0009/009
8) Tributaries of St John's Beck ..... licence no. NW/075/0009/010
9) Black Gill ..... licence no. NW/075/0009/011

The assessment uses water resources modelling outputs to review the physical environment (particularly hydrological and geomorphological) changes between scenarios. The scenarios remain consistent throughout the assessment and are set out in **Table 1-1**.

[8] Note that the water course downstream of the fellside gill of Helvellyn Gill is named Howe Beck

**Table 1-1 Modelled scenarios for assessment**

| Scenario name | Operational Scenario | | Commentary | Mitigation measures included in modelled scenario |
|---|---|---|---|---|
| | West Cumbria Transfer | Flood drawdown | | |
| **Baseline** | Yes | Yes, current flood drawdown agreement 126 Ml/d | Represents the current operating regime | • Compensation flow (from Thirlmere and Mill Gil Aqueduct)<br>• S20 (2015) Fisheries waterbank releases[9]<br>• Large spate release (560 Ml/d) S20 (2021) |
| **Assessment** | Yes | No | Represents the proposed operating regime | • Compensation flow (from Thirlmere and Mill Gil Aqueduct)<br>• S20 (2015) Fisheries waterbank releases |
| **Reference** | No | No | Used as a guide to operation pre-TTS and before FDD releases were made | • Compensation flow (from Thirlmere and Mill Gil Aqueduct)<br>• S20 (2015) Fisheries waterbank releases |
| **Naturalised** | No | No | Provides additional context | • Not applicable |

The report first presents a supporting hydrological assessment to the HRA (**Section 2**) including: discussion on suitable outflow regime for St. John Beck; assessment of changes in outflows between scenarios; and advice on potential mitigation to incorporate into a renewed mitigation Section 20 Agreement. The HRA is then presented in **Section 3**.

This report has been prepared to fulfil two purposes:

1. Support the application for like for like renewal of the nine Thirlmere abstraction licences. The Environment Agency is the competent authority under the Habitats Regulations for the abstraction licence renewals and have a duty to consult with Natural England.

2. Provide an assessment under the Habitats Regulations of cessation of the exiting reservoir level based FDD release regime. UU is the competent authority under the Habitats Regulations for the current FDD release regime and have a duty to consult with Natural England when ceasing the release regime.

[9] The scenarios assume that the fisheries waterbank is used to support upstream migration of Salmon in autumn/winter as this is how it is usually utilised and as set out in the guide to use in the fisheries water bank Section 20. The Section 20 allows for the water bank to be used to support downstream smolt migration in spring however it is not usually operated for this purpose.

# 2 SUPPORTING HYDROLOGICAL ASSESSMENT

The supporting hydrological assessment has been developed to inform the impacts assessed through the HRA (**Section 3**). The supporting hydrological assessment is made up of two component parts:

*i)* Flow requirements of St. John's Beck to support ecological function (**Section 2.1**): review of available data to identify the suitable flows from Thirlmere to St. John's Beck to support its ecological functioning. This will inform the assessment in **Section 2.2.2** and recommendations for mitigation (**Section 2.3**).

*ii)* Assessment of flow changes between scenarios (**Section 2.2.2**): review of the differences in the outflow regime of Thirlmere between baseline, assessment and reference scenarios (see **Table 1-1**.). This assessment particularly reviews the change in high flow events, thresholds and timing informed through **Section 2.1** and will inform recommendations for mitigation (**Section 2.3**).

The section concludes by providing recommendations for mitigation (**Section 2.3**) based on the hydrological assessment for consideration in the HRA (**Section 3**).

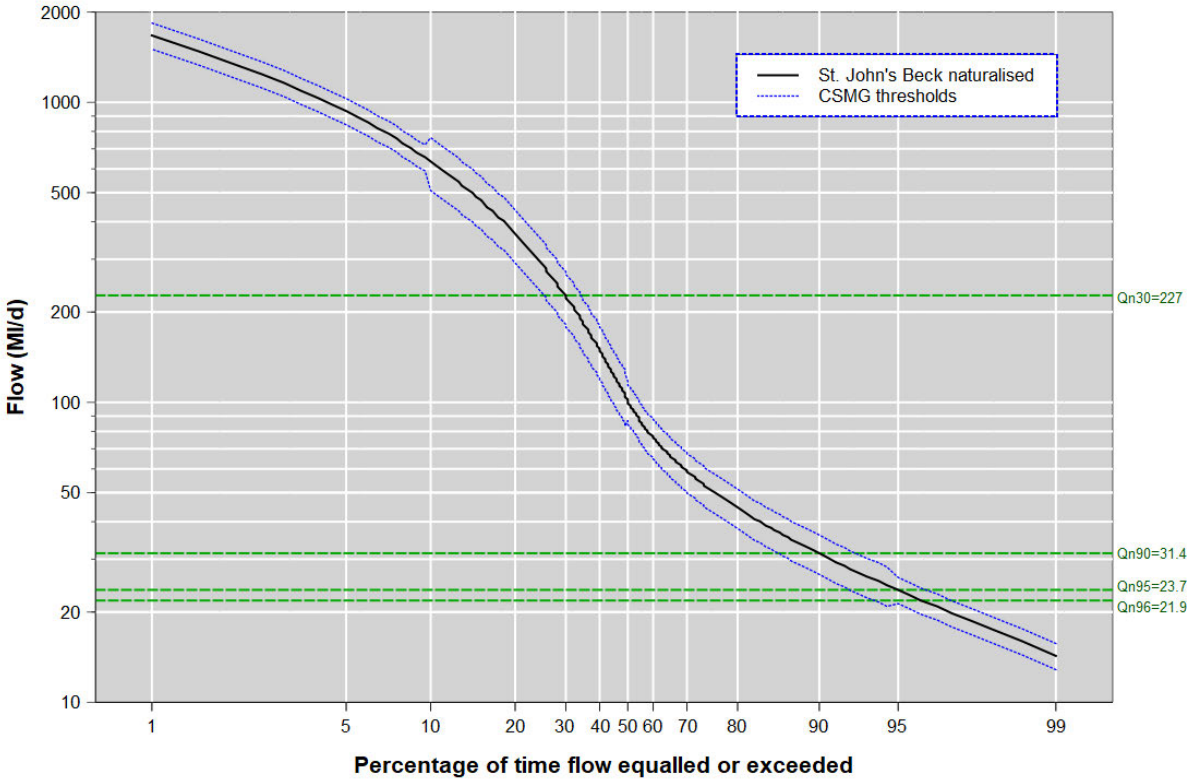
## 2.1 Flow requirements for St. John's Beck to support ecological function

This section, using the UKTAG guidance on the flow building blocks to a river flow regime with Good Ecological Potential[10] as a basis, reviews a natural flow series to explore the peak flow requirements to support the ecological functioning of St John's Beck. A natural flow series is available for the entire 19,200 year stochastic record (using the stochastic inflow series to Thirlmere as proxy). The inflow series used here also contains the inflows to the catchwaters to Thirlmere to ensure the correct flow regime is targeted for the system downstream Howe Beck and Mill Gill. A flow duration curve illustrating the key flow statistics from the naturalised flow series used to generate the UKTAG building blocks is illustrated in **Figure 2-1**.

The flow duration curve also illustrates the CSMG (Common Standards Monitoring Guidance) flow targets for rivers as specified in the CSMG guidance for rivers[11]. The CSMG for rivers also stipulates rivers downstream of a headwater should be tested against a derived benchmark flow regime. Thirlmere Reservoir and St. John's Beck have been subject to extensive hydroecological investigations which have provided a more accurate dataset for the flow requirements for supporting the ecological features of St. John's Beck than the CSMG flow targets. As a result, the CSMG flow targets as illustrated in **Figure 2-1** are considered superseded and are not considered further in this assessment.

10 *cf.* Appendix 6: Background to suggested good ecological potential flow criteria in UKTAG (2013) River flow for good ecological potential Final recommendations
11 JNCC (2016) Common standards monitoring guidance for Rivers, version September 2016

**Figure 2-1 Flow duration curve of naturalised flow for St. John's Beck with key flow statistics indicated.**




The topic of suitable outflows from Thirlmere to support the ecological functioning of St. John's Beck has been subject to extensive consultation historically and UU have an ongoing geomorphological study reviewing coarse sediment transport against peak flows[12]. Information from consultation and the geomorphological study will be used to ground truth the findings from the review of the natural flow regime. It is noted that St. John's Beck has been an impounded reach by Thirlmere since the construction of the reservoir (completed in 1884) so it has been over 140 years since St. John's Beck has been subject to a natural flow regime. As a result, ground truthing of the flow recommendations from the natural flow regime is required as the geomorphology and ecology of the river will not be adapted to the hydrology of a natural flow regime.

The UKTAG guidance sets out the following building blocks:

- Annual Minimum Flow
- Flood Flow (this is analogous to a Small Flood Flow, so from hereout referred to as a 'Small Flood Flow')
- Late Summer Flow Elevations (LSFE)
- Autumn and Winter Flow Elevations (AWFE)
- Spring Flow Elevations.

12 APEM (2025). St John's Beck: Restoration Monitoring Project. APEM Scientific Report P00014640. United Utilities, February 2024, DRAFT

Each building block is discussed further in the relative sections below. Each section explains the expected functions of the building block (i.e. ecological and geomorphological processes that the building block provides), reviews its prevalence in the natural record, reviews evidence available through consultation and the geomorphological study as to what flows are providing the expected function. Each section concludes with a recommendation for the flow for the building block of which will be tested against in the assessment if flow changes between scenarios (**Section 2.2.2**).

### 2.1.1 Annual Minimum Flow

The purpose of the Annual Minimum Flow is set out in the UKTAG guidance as:

a) *To provide a continuously wetted area of habitat capable of maintaining reasonable sized and healthy populations of water plants and animals throughout the year. For fish, this includes sufficient flow and sufficient water depth to facilitate spawning and egg and juvenile growth.*
b) *To maintain exchange of oxygen and the removal of metabolites from gravels.*
c) *To maintain suitable water temperatures and dissolved oxygen concentrations.*
d) *Where possible, by mimicking the timing and magnitude of natural low flow variability (e.g. summer dry episodes), to contribute to ensuring a balance of different plant and animal species and avoiding dominance by species that thrive under stable flow conditions.*

A constant flow of Qn96 is recommended through the guidance, though, should the existing minimum flow be between Qn96 and Qn80, then the existing minimum flow should be retained. The current combined compensation flow (acting as the minimum flow) from Thirlmere to St John's Beck and Mill Gill Aqueduct to Howe Beck of 13.64 Ml/d falls below the Qn96 of 21.9 Ml/d. It is worth noting that, as the natural flow series is based on rainfall-runoff modelling of the modelled catchment the flow attenuation effects of the former lakes in the valley where Thirlmere Dam was constructed (namely Leathes Water and Wythburn Water) are not incorporated into the representation of naturalised flow. See also the Appendix 1 Modelling Report.

The naturalised flow series used to generate the Qn96 is representative of St. John's Beck downstream of Mill Gill so comparison against the compensation release from Thirlmere should also take into account flow contribution from Howe Beck and Mill Gill. Howe Beck provides a downstream flow, licensed as a hands-off flow of 3.0 Ml/d, however, on occasions that 3.0 Ml/d is passed forward from How Beck, the compensation requirement from Thirlmere is reduced by 3.0 Ml/d so the net flow in St. John's Beck downstream of the Howe Beck confluence is maintained at 13.64 Ml/d. For eight weeks between the 3rd week of October and the end of December the penstock on the Mill Gill Aqueduct is opened to Howe Beck, allowing for up to 50 Ml/d to be contributed to St. John's Beck from Howe Beck. There are no further hands off-flow conditions on any of the other intakes intercepted by the Mill Gill Aqueduct under dry flow conditions.

Notwithstanding the UKTAG guidance recommendation, the functions of the Annual Minimum Flow are achieved by the current compensation flow from Thirlmere. This is identified in the Environment Agency's Habitats Directive Review of Abstraction Licenses[13] which states:

*"The compensation flow is set at 13.64 Ml/d at Thirlmere gauging station[14], approximately 800m downstream of the reservoir. In order to determine the suitability of the compensation flow for SAC species, a detailed flow study was undertaken by Atkins consultants (Atkins Consultants, 2005). This investigation assessed depths and velocities at two sites in St John's Beck to determine their suitability for juvenile salmon (juvenile salmon were selected because they have the highest flow requirements of the SAC species). In summary the study found the compensation flow in St John's Beck to be suitable for juvenile salmon, particularly at the most downstream site.*

*This finding is supported by the Agency's electrofishing survey data (see Tables at section 2.4) which typically found high densities of both salmon fry and parr at the survey sites. Lamprey were present at some sites. It is important to note that the technique used to catch and count juvenile salmon is not suitable to determine the densities of lamprey species since they are buried in the silts, usually away from the riffles."*

The suitability of the current licensed compensation flow does not require further consideration.

### 2.1.2 Small Flood Flow

The functions of the Small Flood Flow is set out in the UKTAG guidance as:

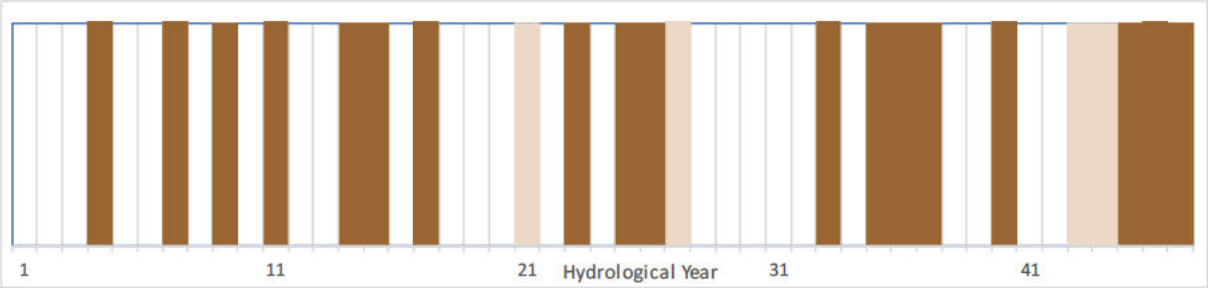
a) *To maintain and refresh channel habitats by redistributing bed surface and sub-surface gravels and cobbles. This includes refreshing gravels prior to fish spawning.*
b) *To prevent riparian vegetation from encroaching into the river channels.*
c) *To flush away build-up of fine sediment and/or plant debris lying on the channel bed or at the river margins.*
d) *To contribute to ensuring a balance of different plant and animal species and avoiding dominance by species that thrive under stable flow conditions.*
e) *To inundate wetlands and marginal areas that act as refuge and nursery habitat for a range of species.*

The Small Flood Flow requirement set out in the guidance is QMED, once every three years between late September to November inclusive. The natural QMED for Thirlmere is calculated as 2,454 Ml/d. Throughout the entire natural stochastic record, the 2,454 Ml/d threshold is surpassed in 50% of water resources years (April-March inclusive) at any time of year, with 28% of years where this threshold is passed within the recommended late September to November period. Though the frequency of these magnitude flows occurring is 1 in 2 years, the regularity does not necessarily mean that one of these

13 River Derwent & Bassenthwaite Lake SAC Appropriate Assessments for the Review of Environment Agency Permissions – Final, September 2006 Part B2 – Water Resources Functional Assessment
14 Noting that the measurement points for compliance now include both the Bridge End flow gauge and the outlet from the Mill Gill aqueduct to Howe Beck, to an assumed sum of 13.64 Ml/d (minimum) at St. John's Beck confluence with Howe Beck

events occurs on a rolling 3 year basis (as per the UKTAG guidance recommendation). This is demonstrated in **Figure 2-2** which shows that there are significant periods (Year 1-3, 18-20 and 28-32) in the modelled natural series where the recommended Small Flood Flow is not achieved within the recommended regularity. This indicates that, though the Small Flood Flow is important for the functionality of St. John's Beck, the recommended frequency of these flows according to UKTAG guidance recommendation is potentially not suitable in the context of St. John's Beck. The recommended frequency is referred to in King *et al* (2008)[15] which scientifically underpins UKTAG guidance, however, this reference also refers to "*Overturning*" flows, understood as the function of the Small Flood Flow, required on "*perhaps once every one to five years*". As such, the precedent that the UKTAG guidance approach is set on does not specify that once on a rolling three year basis for a Small Flood Flow is necessary.

**Figure 2-2 Chart showing the years where the Small Flood Flow target threshold (2,454 Ml/d) as derived from the natural flow series is exceeded for a representative 47 water resources year string. Dark brown indicates that the threshold is surpasses within the specified season for a Small Flood Flow whilst light brown indicates that a flow of Small Flood Flow magnitude was achieved however outside of the specified season.**




Based on impactometer data collected between 25th October 2019 and 14th November 2024[16], coarse sediment movement commences between 1,005 Ml/d and 1,600 Ml/d at the most upstream site at Legburthwaite monitored on St. John's Beck. Movement of sediment was observed as being equally effective[17] between the dates of 10th January 2023 (daily flow of 1,404 Ml/d with an instantaneous peak of 24.8 $m^3/s$ (equivalent to 2,142 Ml/d)), 15th February 2020 (daily flow of 1,546 Ml/d with an instantaneous peak of 26.7 $m^3/s$ (equivalent to 2,307 Ml/d)) and 23rd January 2024 (daily flow of 1,144 Ml/d with an instantaneous peak of 18.58 $m^3/s$ (equivalent to 1,605 Ml/d)). Impactometer data further downstream at the site below Bridge House, noting the more natural geomorphological condition at this site, indicates that flows of greater than 1,500 Ml/d are required to induce moderate coarse sediment transport. This indicates that flows of greater than this magnitude are required to achieve function *a)* of the Small Flood Flow. A review of the impactometer data identified a flow of 23.1 $m^3/s$ (equivalent to 2,000 Ml/d) are required to achieve full bed mobility[18]. With the movement of coarse sediment, functions *b), c) and d)* would also be achieved. Photographic evidence collected by the Environment Agency and West Cumbria Rivers Trust during three Section 20 Large Spate Flow

15 King et al (2008), Environmental Flow Assessments for Rivers: Manual for the Building Block Methodology (Updated Edition), August 2008, Page 171.
16 APEM (2025) St John's Beck: Sediment Transport Report, APEM Ref P00018296.
17 APEM (2025) St John's Beck: Sediment Transport Report, APEM Ref P00018296.
18 APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090

Releases (see Appendix 3) evidences that the Large Spate Flow Release are sufficient to induce inundation of some floodplain and marginal areas (though not deemed sufficient to induce coarse sediment movement). As such, the magnitude of flow required for functions *a) – d)* will be sufficient to achieve function *e).*

The Small Flood Flow requirement of the Section 20 (July 2021) is stated as 20.25 $m^3/s$ (1,750 Ml/d daily equivalent). This has been identified[19] as the QMED using the gauged series from the St. John's Beck gauging station. Despite not being derived from the natural flow series, 1,750 Ml/d (daily equivalent) has been demonstrated as inducing the movement of coarse sediment. As such, this threshold of 1,750 Ml/d (daily equivalent) has been identified as the Small Flood Flow threshold for assessment against in **Section 2.2.2**. The seasonal requirement has also been reviewed in the referenced consultation [19] with the window being extended to September to February inclusive. With this extended season, the natural record does demonstrate that a Small Flood Flow of 2,454 Ml/d is achieved on a one in every three year basis. Based on the impactometer data, with further sediment work in the St. John's Beck catchment, daily mean flows of around 1,500 Ml/d may also provide an instantaneous peak to provide the work of a Small Flood Flow. As such 1,500 Ml/d has also been considered as an indicative threshold for assessment against.

### 2.1.3 Late summer flow elevations

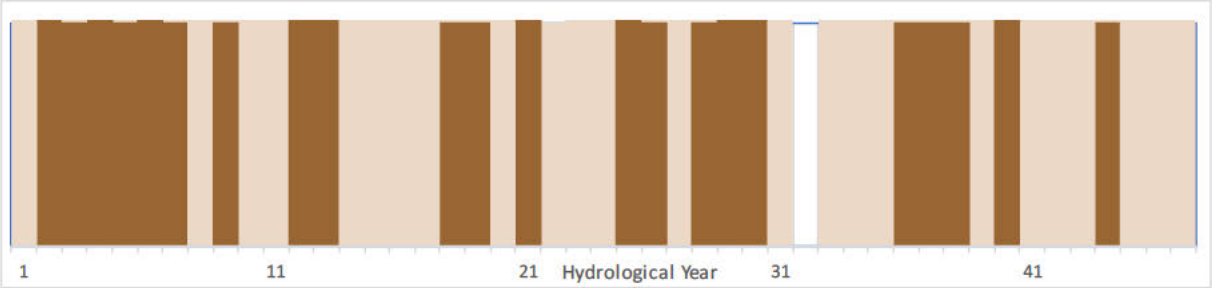
The purpose of the LSFE is set out in the UKTAG guidance to:

*a) To flush away build-up of fine sediment and/or plant debris lying on the channel bed or at the river margins.*
*b) Maintenance of substrate and bedforms e.g. riffles, pools and bars.*
*c) To contribute to ensuring a balance of different plant and animal species and avoiding dominance by species that thrive under stable flow conditions.*

Three LSFEs are recommended in the period August to September inclusive. Two of the LSFEs should be ¾ of Qn30 and one should be 60% of QMED (QMED being the Small Flood Flow value). In the context of the natural series for St. John' Beck, these values are 103 Ml/d and 1,472 Ml/d respectively. Whilst the 103 Ml/d threshold is surpassed in the recommended window in 99% of years in the natural series, the 1,472 Ml/d is only surpassed in 47% of years within the desired window. This is illustrated in **Figure 2-3** where 53% of years fail to achieve the threshold within the window, including a five year period between modelled Year 31-34. Similar to the Small Flood Flow, this indicates that an annual flow of this magnitude between August-September is not a function of the natural flow regime in this system.

19 Email from Colin Rigg, Environment Agency to Kat Liney, United Utilities – 24 May 2023 15:00

**Figure 2-3 Chart showing the years where the higher LSFEs threshold (1,472 Ml/d) as derived from the natural flow series is exceeded for a representative 47 water resources year string. Dark brown indicates that the threshold is surpasses within the specified season for a LSFEs whilst light brown indicates that a flow of this magnitude was achieved however outside of the specified season.**




Impactometer data from the geomorphological studies indicates that there is no notable bed-material transport under the FDD releases of 120 Ml/d so it is unlikely that the suggested 103 Ml/d from the natural flow series would be sufficient magnitude to induce the geomorphological functions of a LSFE.

Previous review of building block functional requirements in St John's Beck[20] identified that none of the functions associated with a LSFE were missing from the habitat or ecological response, and as such are not required as managed releases. This review identifies that the requirements to omit a large LSFE according the building blocks methodology are achieved with the provision of AWFE.

Currently, as part of the Mitigation Section 20 Agreement (2021), UU release 560 Ml/d daily equivalent flow (6.5 $m^3/s$ for 6 hours duration) between 1st September to 15th November (noting head on the reservoir means that sometimes it is not possible to achieve this value). This period overlaps with the UKTAG timing of a LSFE. However, review[21] of the timing of a AWFE elevation recommended avoiding making managed high flow releases in August, October and November – hence the original Mitigation Section 20 Agreement (2021) listing the AWFE release in September, although this was later revised to extend to 15th November. However, the function of that managed release remains as an AWFE not a LSFE

For completeness, an LSFE is included for testing in **Section 2.2.2,** with 560 Ml/d included as a threshold - as this is demonstrated from the impactometer data to induce the movement of fine material, thus this magnitude of flow is sufficient for achieving the geomorphological functions, *a) and b.*

### 2.1.4 Autumn and winter flow elevations

The purpose of the AWFEs is set out in the UKTAG guidance to:

*a) To support the migration of adult salmon, sea trout, river lamprey and sea lamprey into rivers and the migration of these species and brown trout in rivers to their spawning grounds.*

*b) To support the dispersal of juvenile non-salmonid species.*

[20] APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090
[21] APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090

c) *To support the downstream migration of silver eels and salmonid kelts towards the sea.*

d) *To flush away build-up of fine sediment and/or plant debris lying on the channel bed or at the river margins.*

e) *To contribute to ensuring a balance of different plant and animal species and avoiding dominance by species that thrive under stable flow conditions.*

AWFEs are recommended by the UKTAG guidance on a weekly basis throughout October, November and December of a magnitude of 6x Qn95, which equates to 142.2 Ml/d for Thirlmere. Flow of this magnitude is achieved in this window in 99.99% of years in the natural stochastic record, not necessarily as a weekly frequency.

There is limited information in the context of Thirlmere and St. John's Beck as to the magnitude of flows required to induce function a), *b)* and *c)*. Previous review[22] of the flow requirements for migration stimulus flows for St. John's Beck indicates that flow elevations to between 85-200 Ml/d are required to induce upstream salmon migration. The review highlights that there is a risk to the success of salmon spawning (egg incubation) should the flow be maintained at this higher rate (for example through KFAG releases) rather than being managed as a spate flow due to the risk of the spawning site being dewatered when the flow is reduced back to compensation flow. The review notes that there is no evidence of adult fish stranding as a result of the rapid transition from KFAG flows to compensation flows but does not comment on the risk of egg stranding.

Impactometer data indicates that migration stimulus magnitude flows would be insufficient to achieve function *d)*, and therefore unction *e)*. As such, as per the LSFEs, a release of 560 Ml/d is recommended to provide the geomorphological functions of the AWFEs. It is only recommended that this occurs once in the recommended window. For eight weeks between the 3rd week of October and the end of December (overlapping with the AWFE period) the penstock on the Mill Gill Aqueduct is opened to Howe Beck, allowing for up to 50 Ml/d to be contributed to St. John's Beck from Howe Beck. This can be used to supplement a 560 Ml/d AWFE release to improve the likelihood that these releases provide the geomorphological functions of an AWFE in St John's Beck downstream of Howe Beck. .

With the functions required of the AWFE requiring different flow criteria, two tests have been undertaken for the AWFE threshold in **Section 2.2.2**:

- Migration stimulus flows AWFE – flow elevations to within the migration stimulus threshold of 85-200 Ml/d (within the waterbank period of late October to mid-December)
- Large AWFE – 560 Ml/d between October to December inclusive.

The assessment notes that, where required, flows to provide this function of the migration stimulus flows are currently provided by the fisheries waterbank releases as stipulated in the fisheries releases Section 20 agreement (2015). The waterbank has been noted as sufficient for supporting upstream

[22] APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090

salmon migration through previous review[23]. The fisheries waterbank remains consistent between all scenarios (excluding the natural scenario).

### 2.1.5 Spring Flow Elevations

The purpose of the Spring Flow Elevations is set out in the UKTAG guidance to:

*a) To support downstream migration to sea of salmon and sea trout smolts, including past man-made and natural obstacles.*

*b) To support migration of non-salmonid species, including shad and sea lamprey, to spawning areas.*

Spring Flow Elevation releases are recommended to occur weekly throughout March to June inclusive. Though, for St. John's Beck, its location high up in the catchment more likely means that the preferred emigration window for smolt is April to May inclusive. The recommended magnitude of a Spring Flow Elevation in the context of Thirlmere and St. John's Beck is Qn90 (31.4 Ml/d). Multiple peak flows, though not necessarily on a weekly basis, of significantly greater than this magnitude are almost always observed in the naturalised series, particularly in the early months of the recommended window. As such, Spring Flow Elevations are a feature of the natural flow regime for St. John's Beck, however at a greater magnitude and potentially a different frequency.

UU, in collaboration with the Environment Agency, made a 0.96 $m^3/s$ smolt release in spring 2025 for 21 hours, as measured at St John's Beck at Thirlmere flow gauge. This smolt release was demonstrated as effective with the movement of over 300 smolt into a smolt trap in St. John's Beck[24]. As such, 0.96 $m^3/s$ is confirmed as providing function *a)* and likely function *b)* of the Spring Flow Elevation. The value of 0.96 $m^3/s$ is 0.81 $m^3/s$ higher than the compensation flow of 13.64 Ml/d, and if delivered for a 24 hour period would be an increase of 70 Ml/d over the compensation flow and use 70 Ml of reservoir storage. A 70 Ml/d flow elevation (above compensation flow) has been tested against as the Spring Flow Elevation in **Section 2.2.2**.

## 2.2 Assessment of flow changes between scenarios

Based on the findings of the review of the flow requirements for St. John's Beck (**Section 2.1**), this section assesses the hydrological changes between scenarios (scenarios are set out in **Section 1.2**). The approach to the assessment is documented in **Section 2.2.1** and the assessment is presented in Section 2.2.2. The outcomes of this assessment inform the recommendations in **Section 2.3** and the HRA (**Section 3**). At the request of the Environment Agency, the representative 47 years output from the naturalised series is presented in Appendix 2.

[23] APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090
[24] Phil Ramsden, Environment Agency Fisheries Officer, *pers comm*, May 2025.

### 2.2.1 Approach

The hydrological assessment has been undertaken to assess the changes to the flow regime of St. John's Beck as a result of the licence renewal. The assessment particularly focusses on hydrological and geomorphological changes, though change to water quality (particularly water temperature) has also been considered at a higher level. These changes are then used to inform the assessment of the aquatic ecology receptors for the HRA (**Section 3**) by identifying and characterising potential impact pathways to the receptors. Through historical investigations on the St. John's Beck system, the pathways to impacting any ecological receptors as a result of operational regime and releases made from the reservoir are mostly limited to geomorphological functions associated with the high flow regime. Potential reductions in the spill regime could result in a reduction in geomorphological work[25] in the system.

To understand the hydrological impacts on St. John's Beck associated with reservoir operations, this assessment utilises UU Aquator™ water resources modelling outputs. The model provides the daily flow from Thirlmere (both managed releases and reservoir spill) to St. John's Beck on a daily timestep for 19,200 model years (400 strings of 48 calendar years) per modelled scenario[26]. Three scenarios have been utilised in this assessment and are presented in **Table 1-1**. Modelled reservoir storage and abstraction data has been used to supplement the assessment. The demand scenario used in the model is the demand scenario used for WRMP24.

The reference scenario matches the operation of Thirlmere that was used as the baseline for the 2016 HRA for the TTS (further discussed in **Section 2.2.2**).

The baseline and assessment scenario have been compared (with the reference scenario used as a guide) to identify how the reservoir outflow regime differs between the scenarios against flow thresholds that have been identified as driving important geomorphological/ecological processes in St. John's Beck. From the review of the flow elevation requirements for St. John's Beck to support its ecological functioning (see **Section 2.1**) six flow thresholds and the baseline flow have been identified and are presented in **Table 2-1.**

By comparing how the reservoir outflow under the baseline and assessment scenarios differ through the lens of the thresholds for geomorphological processes presented above, the potential impacts on the physical environment and therefore SAC qualifying features can be characterised.

The assessment has initially reviewed each water resources year (1st April – 31st March) of the entire 19,200 calendar year stochastic series for each scenario. With the assessment taking into account full hydrological years, there are 47 water resources years in a 48 calendar year string, with the 1st and 48th calendar year not containing a full water resources year. This means that 18,800 full water resources years are considered in this assessment. The model output of the full stochastic series includes very

25 Geomorphological work is the capacity of a river flow to alter the geomorphology of a river channel, for example by initiating sediment transport or causing bank erosion. In simple terms the higher the flow, the higher its energy and the greater the potential for geomorphological work which the flow can do.
26 The model does not have a node to represent flow to St. John's Beck from the Mill Gill Aqueduct via Howe Beck.

rare extremes of low rainfall through to very rare extremes of high rainfall, with that rainfall affecting Thirlmere storage and the consequent outflow regimes.

**Table 2-1 Flow thresholds to support the ecological functioning in St. John's Beck**

| Threshold name | Target flow | Target season |
|---|---|---|
| **Baseline flow** | 13.64 Ml/d (0.158 $m^3/s$) | Year-round |
| **Spring Flow Elevation** | 84 Ml/d (0.97 $m^3/s$) (70 Ml/d increase above compensation flow) | April to May inclusive (wider seasons include March to June inclusive) |
| **Late Summer Flow Elevations (LSFE)** | 560 Ml/d (6.48 $m^3/s$) | August to September inclusive |
| **Large Autumn and Winter Flow Elevations (AWFE)** | 560 Ml/d (6.48 $m^3/s$) | October to December inclusive |
| **AWFE migration stimulus** | Five occasions of flow elevation to between 85-200 Ml/d (0.98 $m^3/s$-2.31 $m^3/s$) | Late October to mid-December |
| **Small Flood Flow 1** | 1,500 Ml/d (17.36 $m^3/s$) | Late September to February inclusive |
| **Small Flood Flow 2** | 1,750 Ml/d (20.25 $m^3/s$) | Late September to February inclusive |

Following the review of the entire stochastic series, to explain the trends identified in the review, the assessment then focusses a 47 water resources year string that has been selected after a review of the low flow return frequencies for the years in the baseline scenario. The selected string has a suitable distribution of low flow return frequencies and has avoided strings with extreme high or low flow years (see Appendix 1 for more details on the selection of the representative string). Daily flows and reservoir storage for a 5-year period of the selected string have then been reviewed to further explain identified trends between scenarios.

### 2.2.2 Assessment

The outcomes of the review of the full 18,800 water resources year stochastic dataset for each scenario is presented in **Figure 2-4**. The scenarios assessed are as set out in **Table 1-1** and include the relevant managed releases for each scenario. To recap, the baseline scenario includes: Compensation flow (from Thirlmere and Mill Gil Aqueduct), Section 20 Agreement (2015) Fisheries waterbank releases and large spate release (560 Ml/d) Section 20 Agreement (2021). The assessment scenario and reference scenario each include compensation flow (from Thirlmere and Mill Gil Aqueduct) and Section 20 Agreement (2015) Fisheries waterbank releases.

In summary, the assessment scenario (where TTS is operational with no FDD release) exceeds each of the high flow assessment thresholds, with the exception of the spring flow elevation threshold of 84 Ml/d, more frequently than the baseline scenario (where both of the TTS and FDD releases are operational).

The magnitude of the Small Flood Flow threshold is achieved in greater than a third of years in both the assessment scenario and reference scenario, noting that the threshold is not surpassed within the desired seasons on this frequency for the assessment scenario whereas it is in the reference scenario.

As demonstrated later in this section, though this threshold is surpassed in over 33% of years, it is not on a regular 1 in every 3 year basis (as required in the current Section 20) in either scenario.

Analysis of the consecutive number of years across the entire stochastic 18,800 water resources year stochastic series for the Small Flood Flow 1 and Small Flood Flow 2 thresholds is set out in **Table 2-2** and **Table 2-3** respectively. Generally, between the baseline scenario and assessment scenario, there is a lower frequency of gaps of more than five years without a Small Flood Flow event, with more high flow events in the assessment scenario breaking up the gaps that are observed in the baseline scenario.

The following sections review these results in greater detail. Firstly, a comparison of the baseline scenario and assessment scenario has been undertaken to demonstrate how the licence renewal would change the flow regime to St. John's Beck compared to the current baseline operation of Thirlmere. Secondly, the assessment scenario has been compared to the reference scenario to review that the impact that the TTS abstraction has on the flow regime compared to a scenario where TTS is not operational (as well as the FDD release not being operational). Finally, the key findings from the physical environment assessment have been summarised to inform future management of Thirlmere and the aquatic ecology assessment in **Section 2.3** and **Section 3** respectively.

**Figure 2-4 Percentage of hydrolgical years (1st April to 31st March) where each flow threshold is surpassed per scenario. Solid colours indicate that the threshold is passed within the desired season for its corresponding function, with light coloured bars indicating that the threshold is passed outside of the desired seasons. The striped bar for the 84 Ml/d threshold indicates that the threshold is passed in the wider season range for a spring flow elevation.**

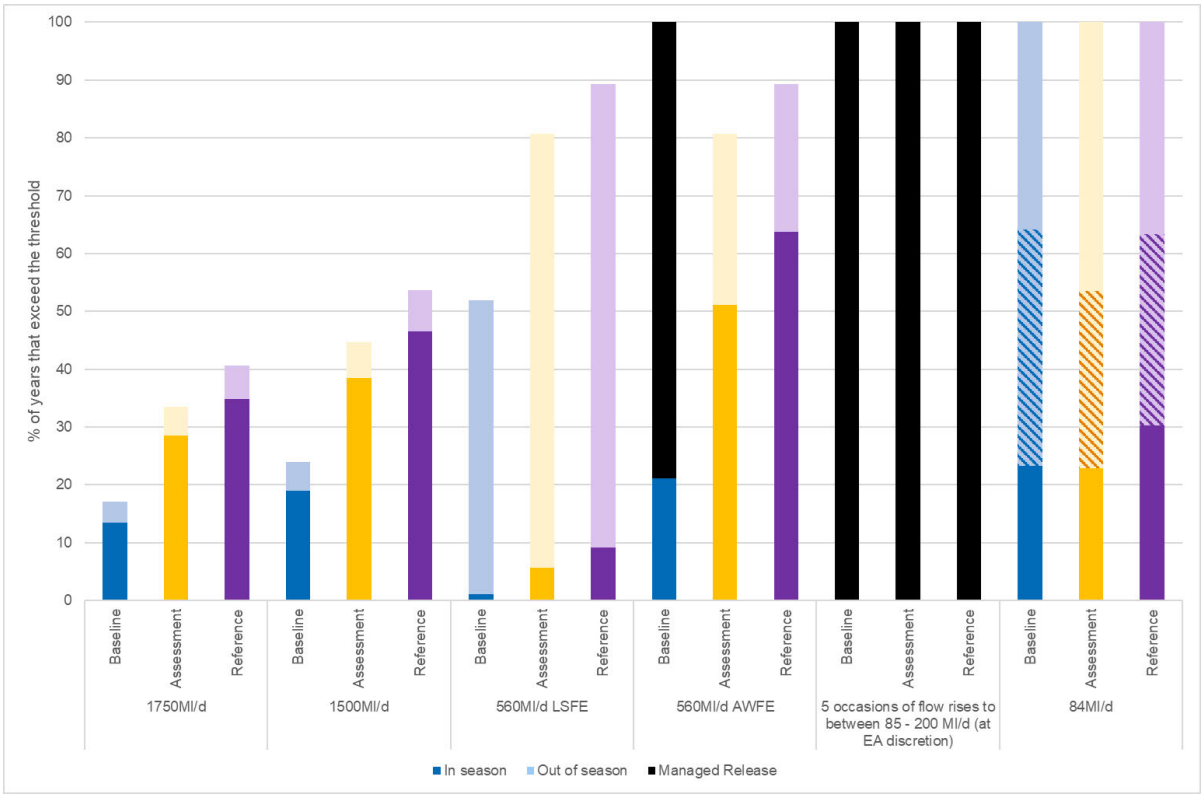


**Table 2-2 Number of consecutive years, across the 18,800 stochastic years series, without a Small Flood Flow 1 magnitude flow (1,500 Ml/d)**

| Number of consecutive years without Small Flood Flow 1 magnitude flow | Baseline | Assessment | Reference |
|---|---|---|---|
| 1 | 975 | 2,300 | 2,763 |
| 2 | 844 | 1247 | 1,175 |
| 3 | 387 | 465 | 453 |
| 4 | 348 | 323 | 248 |
| 5 or more | 1,090 | 468 | 216 |
| Maximum number of consecutive years | 27 | 16 | 10 |

**Table 2-3 Number of consecutive years, across the 18,800 stochastic years series, without a Small Flood Flow 2 magnitude flow (1,750 Ml/d)**

| Number of consecutive years without Small Flood Flow 2 magnitude flow | Baseline | Assessment | Reference |
|---|---|---|---|
| 1 | 610 | 1,706 | 2,166 |
| 2 | 594 | 1,115 | 1,223 |
| 3 | 279 | 479 | 505 |
| 4 | 280 | 387 | 373 |
| 5 or more | 1,215 | 802 | 548 |
| Maximum number of consecutive years | 37 | 24 | 16 |

**Comparison of baseline and assessment scenarios**

This section compares the baseline and assessment scenario through the lens of an illustrative and representative 47 water resources year string. The approach to selecting the representative 47 water resources year string is set out in Appendix 1.

**Figure 2-5** compares the difference between the baseline and the assessment scenario for the Small Flood Flow 2 threshold (1,750 Ml/d) for the representative string years. Every water resources year where there is a flow that exceeds this threshold within the desired season for a Small Flood Flow (20th of September- 28th of February) is represented in dark blue (baseline scenario) and dark yellow (assessment scenario). Where the flow exceeds the threshold outside of this period it is represented by a lighter shade. For the Small Flood Flow 2 threshold, the baseline scenario flows exceed this threshold in eight of the water resources years (17%), six of which with the desired seasonality (13%). Comparatively, the assessment scenario exceeds the threshold in 16 of the water resources years (34%),of which 14 (30%) are within the desired season. As **Figure 2-5** shows, there is a higher number of water resources years that fail to exceed the threshold in the baseline scenario with up to 11 consecutive water resources years without a flow over 1,750 Ml/d, whilst in the assessment scenario this is reduced to eight water resources years. The assessment scenario is therefore closer to the target frequency of the Small Flood Flow in the current Section 20 agreement of exceeding the threshold once every three years, albeit, there are still some periods of greater than three years where the threshold is

not surpassed. As presented in **Section 2.1.2**, a one in every three year return frequency is not a feature of the natural flow regime for St. John's Beck, noting the seasonal window of the UKTAG guidance building blocks recommendations for the Small Flood Flow is a shorter period than that suggested suitable for St. John's Beck (see **Section 2.1.2**).

**Figure 2-6** compares the difference between the baseline and assessment scenario for the Small Flood Flow 1 threshold (1,500 Ml/d) for the representative string years. In the baseline scenario, the Small Flood Flow 1 threshold is exceeded in 11 of the water resources years (23%), of which nine are within the desired season (19%). Comparatively the assessment scenario exceeds this threshold in 24 of the water resources years (51%), 21 of which are within the desired season (45%). As shown in **Figure 2-6**, there are significantly longer periods between Small Flood Flow 2 in the baseline scenario, with up to 10 consecutive water resources years without a flow over 1,500 Ml/d. In the assessment scenario, this is reduced to four years, with a much higher frequency of years exceeding the threshold, with only two instances where there are three consecutive years without a Small Flood Flow.

**Figure 2-7** and **Figure 2-8** compare the difference between the baseline and assessment scenarios for the threshold of 560 Ml/d, for the representative string water resources years. Overall, at any time of year, for the 560 Ml/d threshold there is an increase from 25 water resources years (53%) where the threshold is exceeded in the baseline scenario to 38 water resources years (81%) in the assessment scenario without managed releases being required. With the inclusion of managed releases, the baseline scenario achieves this threshold in all years due to the Large spate release as specified in the Section 20 (2021).

**Figure 2-7** presents the threshold for the LSFE where the darker colours represent the period August to September inclusive. Within the desired seasons for the LSFE threshold, shown in **Figure 2-7**, the baseline scenario achieves the threshold in three water resources years (6%), with the assessment scenario achieving the threshold in the desired season in seven water resources years (15%). As set out in **Section 2.1.3**, a LSFE magnitude flow between August-September is not a function of the natural flow regime in this system.

**Figure 2-8** presents the threshold for AWFE, where the darker colours represent the period October to December inclusive. For the AWFE threshold shown in **Figure 2-8** , the baseline scenario achieves the threshold for 11 years (23%), with the assessment scenario achieves 25 years (53%) within the desired season without the need for a managed release. With managed releases included, the baseline scenario always achieves a flow of this magnitude in the desired seasons of an AWFE. **Section 2.1.4** indicates that AWFE magnitude flows are observed between October to December on an annual frequency as part of the natural regime for St. John's Beck.

Review of the number of flow rises to stimulate upstream migration of salmon is presented **Figure 2-9**. In the representative 47 water resources year period, there are no years in either the baseline or assessment scenario where five flow elevations to within the threshold to stimulate upstream migration (as identified in Section 2.1.4) are achieved without the managed Section 20 (2015) fisheries waterbank releases. Due to the implementation of the KFAG releases, there are more years in which some of the

flow rises are achieved without the need for the fisheries waterbank in the baseline scenario (26 years) compared to the assessment scenario (3 years).

**Figure 2-10** compares the difference between the baseline scenario and assessment scenario for the Spring Flow Elevation threshold (84 Ml/d), for the representative string water resources years. The 84 Ml/d threshold is achieved every year, the graph represents the years where the threshold is achieved outside of the wider season in light grey. The preferred season is presented as the darker colours, with the flows exceeded outside of the preferred season, but still within the wider season presented as the lighter colours. There are 10 years (21%) in both the assessment and baseline scenarios that achieve the threshold in the preferred season. There are four years where the assessment scenario achieves the threshold in the preferred season where the baseline does not. There are also occasions where the FDD releases mean that the magnitude of the Spring Flow Elevation is achieved in the baseline scenario but not the assessment scenario (noting the FDD releases do not mimic the rising and falling nature a peak flow and last for a longer duration). In the baseline scenario there are extended periods where the threshold is not achieved in the preferred season, the largest being 19 years. This is reduced in the assessment scenario, with the largest period without a flow exceeding 84 Ml/d in the preferred season is 12 years. **Section 2.1.5** demonstrates that Spring Flow Elevations are a feature of the natural flow regime for St. John's Beck.

The hydrograph in **Figure 2-11** shows the difference between the flow and storage for the baseline scenario and assessment scenario for a selected period of five water resources years within the representative string[27]. In all five water resources years, there is significant drawdown in the reservoir storage in periods in the baseline scenario (coinciding with the FDD releases) compared to the TTS Only scenario. This then results in the first reservoir spill event of the year, as seen in the assessment scenario, to not be represented in the baseline scenario or to be of decreased magnitude. In this case all peak flows greater than the thresholds presented in this assessment are completely missing from the baseline scenario in the final year represented.

It is worth noting that the assessment has reviewed daily average flows from a water resources model and does not infer sub-daily variability.

[27] Five year sequence has been selected to illustrate a range of scenarios from the 47 hydrological string based on expert judgement.

**Figure 2-5 Chart showing the years where flow exceeds the threshold for the Small Flood Flow 2 (1,750 Ml/d) for a representative 47 water resources year string for the baseline and assessment scenarios.**

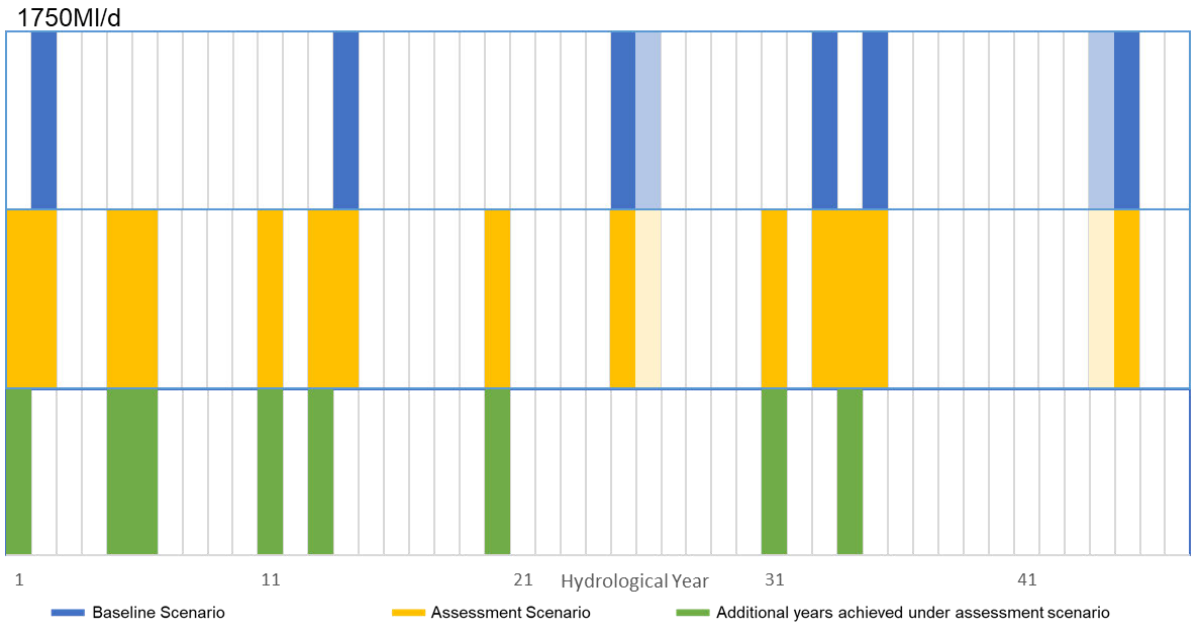



**Figure 2-6 Chart showing the years with where flow exceeds the threshold for the Small Flood Flow 1 (1,500 Ml/d) for a representative 47 water resources year string for the baseline and assessment scenarios.**

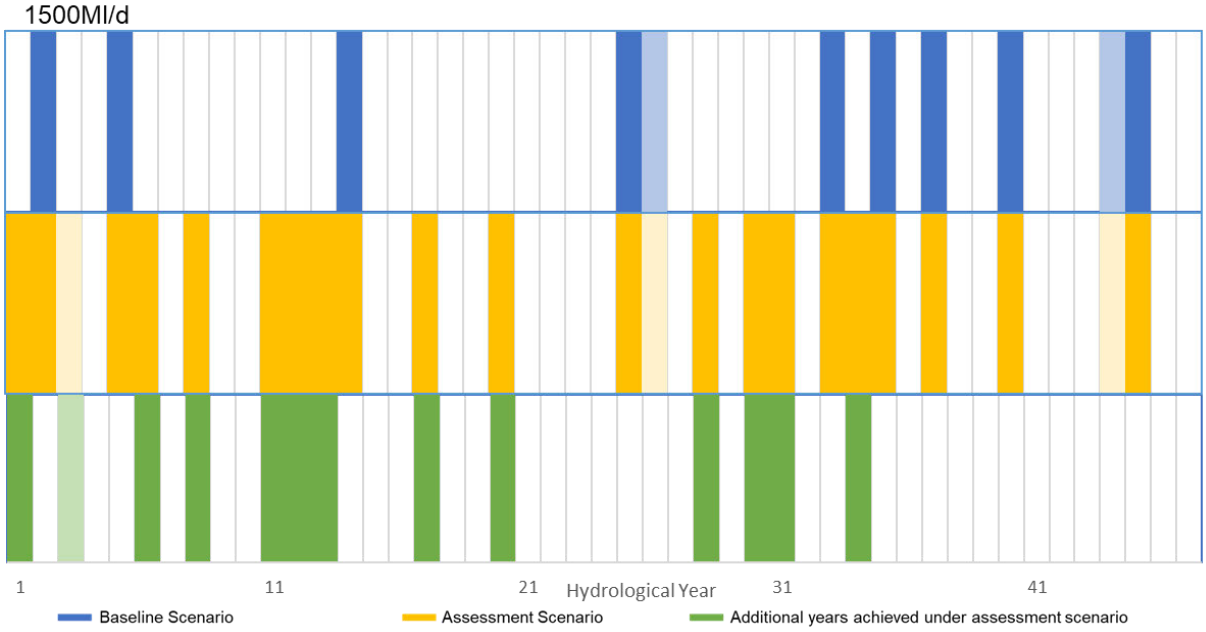


**Figure 2-7 Chart showing the years where flow exceeds the threshold for the LSFE (560 Ml/d) for a representative 47 water resources year string for the baseline and assessment scenarios.**

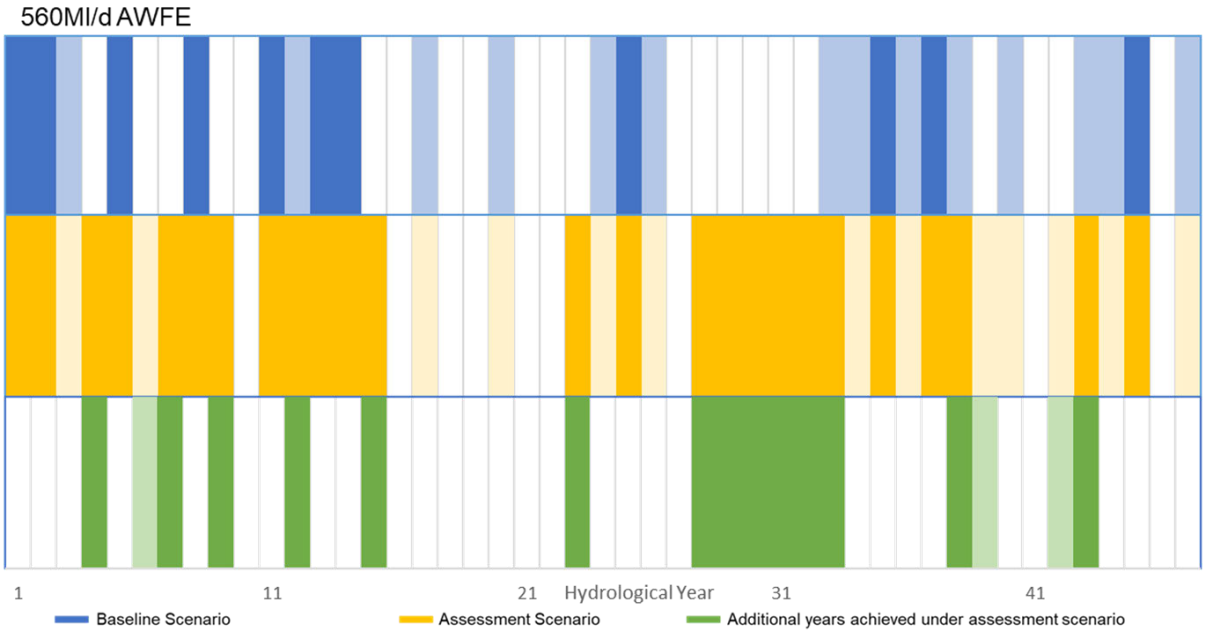



**Figure 2-8 Chart showing the years where flow exceeds the threshold for the AWFE (560 Ml/d) for a representative 47 water resources year string for the baseline and assessment scenarios.**

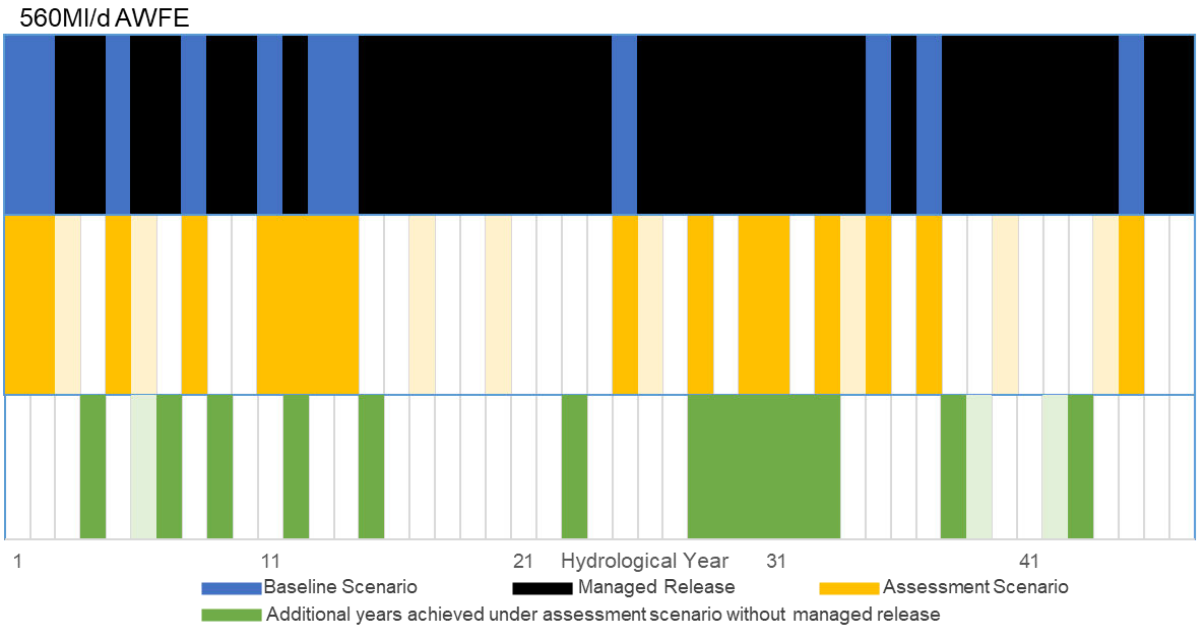


**Figure 2-9 Chart showing the extent of managed releases required to deliver five discrete peaks of 85 Ml/d – 200 Ml/d in the late October to mid December period for adult Atlantic salmon migration, as a component of the AWFE for a representative 47** water resources **year string for the baseline and assessment scenarios. Colours indicate that some of the discrete flow elevations are achieved without the need of the S20 waterbank release.**

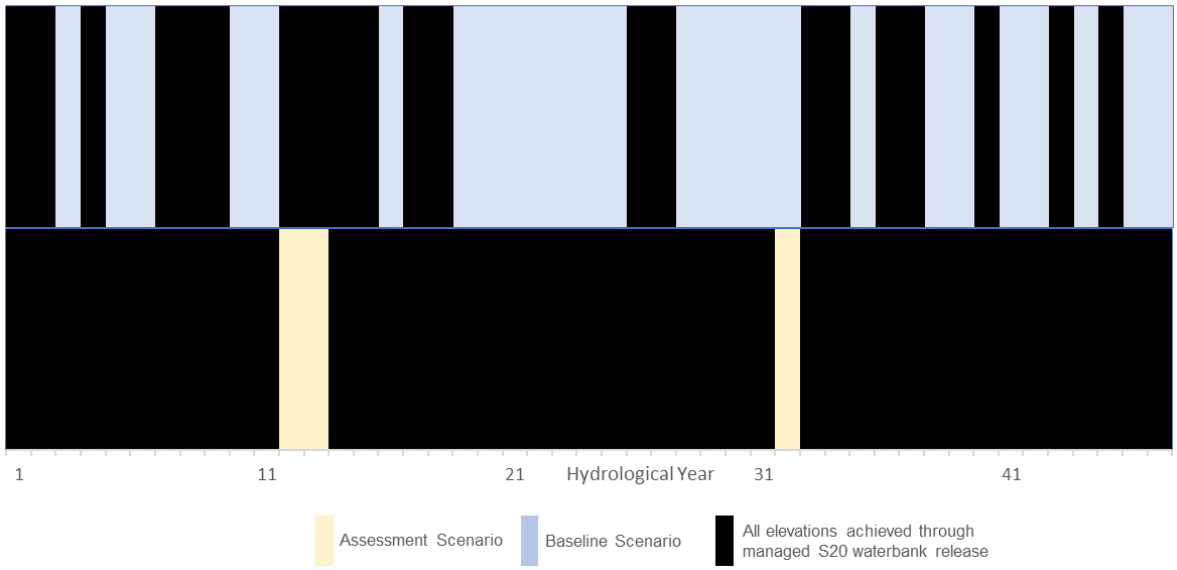



**Figure 2-10 Chart showing the years where flow exceeds the threshold for the Spring Flow Elevation (84 Ml/d) for a representative 47 water resources year string for the baseline and assessment scenarios. The dark coloured bars represent flows exceeding the threshold in the preferred season (April-May inclusive), the light-coloured bars represent flows exceeding the threshold outside of the preferred season (March to June inclusive), and the grey bars represent flows exceeding the threshold outside of the season.**

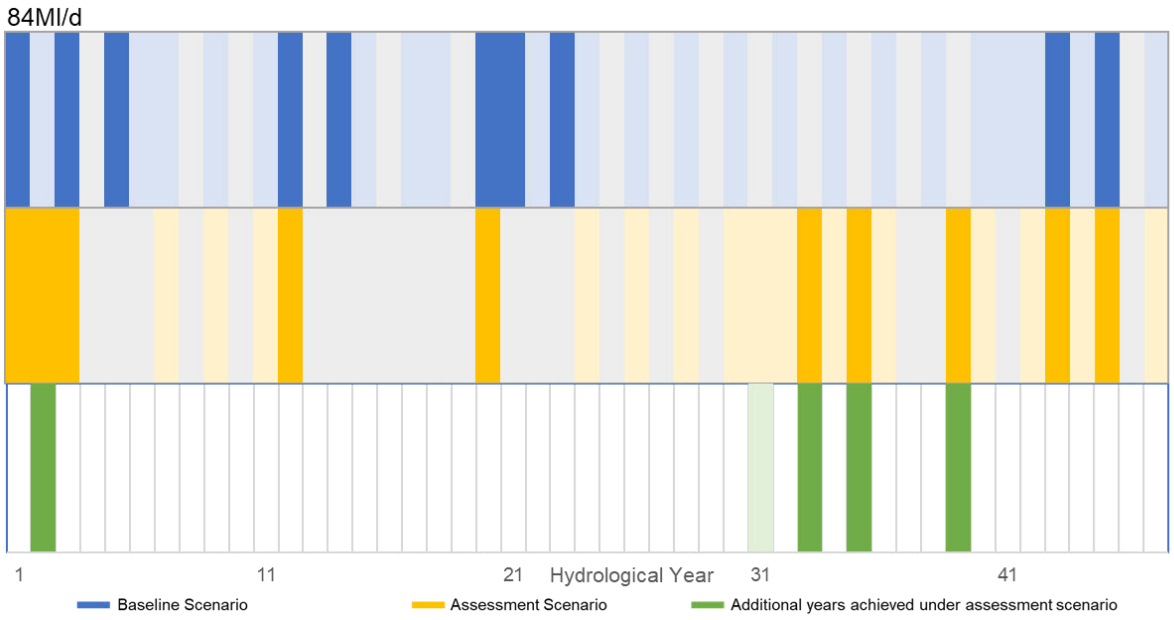
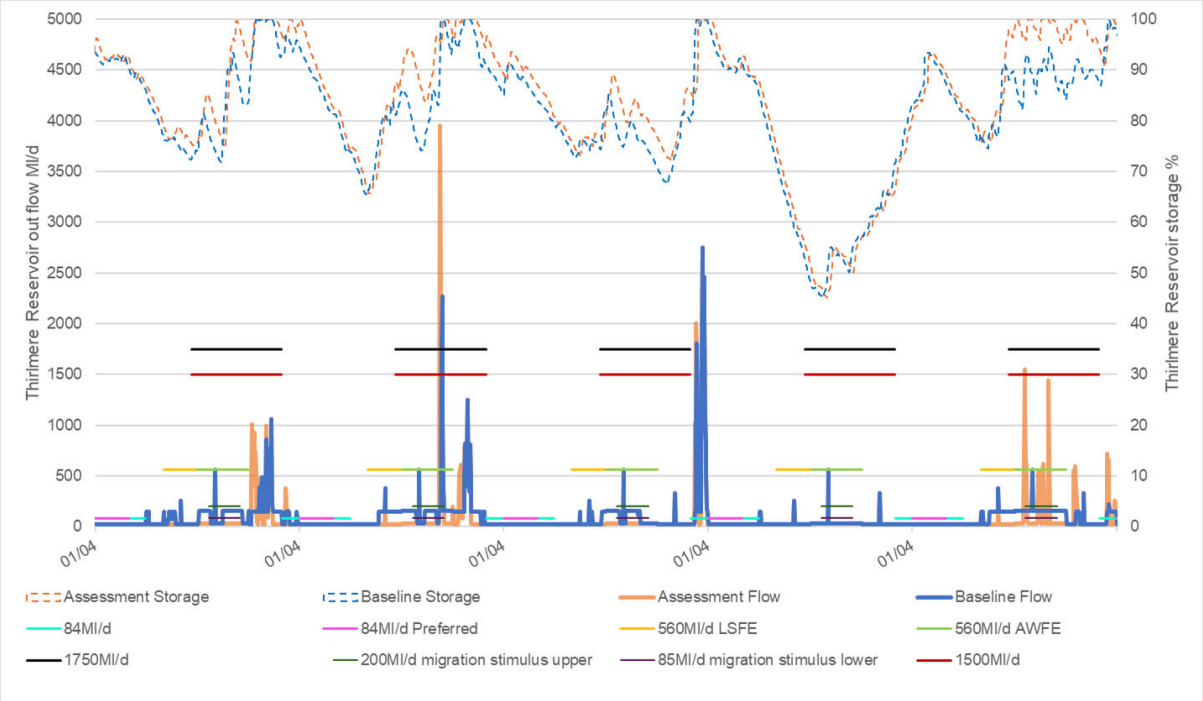


**Figure 2-11 Hydrograph comparing the modelled outflow to St. John's Beck and reservoir storage between the baseline scenario and the assessment scenario for a selected 5-year period (Year 24 to Year 28). Flow thresholds and desired seasons for each of the building blocks set out in Section 2.1 are included in the figure.**




### Comparison against reference scenario

This section compares the assessment and reference scenario through the lens of a representative 47 water resources year string. The approach to selecting the representative 47 water resources year string is set out in **Appendix 1**.

**Figure 2-12** compares the difference between the reference and assessment scenarios, for the Small Flood Flow 2 threshold (1,750 Ml/d) for the representative string water resources years. Every water resources year where there is a flow that exceeds this threshold within the desired season (20th of September- 28th of February), this is represented in dark purple (reference scenario) and dark yellow (assessment scenario). Where the flow exceeds the threshold outside of this period it is represented by a lighter shade. For the Small Flood Flow 2 threshold, the reference scenario flows exceed this within the desired season in 20 of the years (43%), whilst the assessment scenario exceeds this in 14 of the years (30%) within the season. **Figure 2-12** shows there are six water resources years where the flow exceeds the threshold for the reference scenario but not the assessment. The assessment therefore has longer periods where there is not a flow exceeding the threshold, with the longest being eight years, compared to four water resources years in the reference scenario. With this, in the reference scenario, there are still four periods in the representative string where there are no flows of Small Flood Flow 2 magnitude within a three year period as required by the current Section 20 agreement. Compared to the baseline scenario, the assessment scenario moves the number and frequency of events of this magnitude, at any time of year and in the desired season, closer to the number in the reference scenario.

**Figure 2-13** compares the difference between the reference and assessment scenario for the Small Flood Flow 1 threshold (1,500 Ml/d) for the representative string years. For the Small Flood Flow 1 threshold, the reference scenario flows exceed this within the desired season in 30 water resources years (64%), whilst the assessment scenario exceeds in for 21 water resources years (45%) within the desired season. **Figure 2-13** shows that there are nine additional water resources years where the flow is exceeded in the desired season in the reference scenario than the assessment. There is a maximum period of two years in the reference scenario where there is not a flow exceeding the threshold, for the assessment scenario this is four years. As with the Small Flood Flow 2 threshold, the assessment scenario moves the number and frequency of events of this magnitude, at any time of year and in the desired season, closer to the number in the reference scenario compared to the baseline scenario.

**Figure 2-14** and **Figure 2-15** compare the difference between the reference and assessment scenarios for the threshold of 560 Ml/d, for the representative string years. Overall, in the entire year, for the 560 Ml/d threshold there is a decrease from 43 water resources years (91%) exceeded for the reference to 38 water resources years (81%) for the assessment scenario.

**Figure 2-14** presents the threshold for Late Summer Flow Elevations (LSFE) where the darker colours represent the period August to September inclusive. Both the reference and assessment scenario achieve LSFE threshold flows in this period in seven water resources years (15%) which is significantly less than the recommended annual frequency of a LSFE as specified in the UKTAG guidance. Figure 2-15 presents the threshold for Autumn and Winter Flow Elevations (AWFE), where the darker colours represent the period October to December inclusive, the lighter colours represent flows exceeding the threshold outside of the selected season. The reference scenario achieves the threshold of an AWFE flow within the preferred seasons in 30 water resources years (64%) whilst the assessment achieves this in 25 water resources years (53%). Again, this is less than the annual frequency required for an AWFE as specified in the UKTAG guidance.

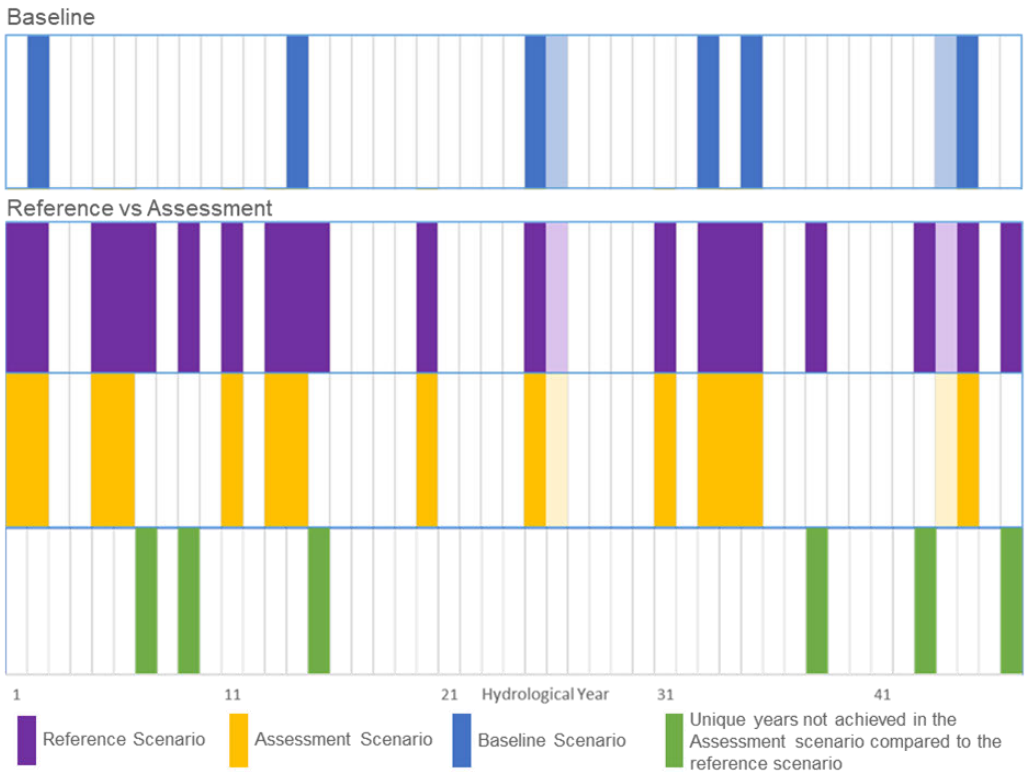
Review of the number of flow rises to stimulate upstream migration of salmon is presented **Figure 2-16**. In the representative 47 water resources year period, there are no years in either the assessment or reference scenario where five flow elevations to within the threshold to stimulate upstream migration (as identified in Section 2.1.4) are achieved without the managed Section 20 (2015) fisheries waterbank releases. There are greater years in which some of the flow rises are achieved without the need for the fisheries waterbank in the reference scenario (six years) compared to the assessment scenario (3 years).

**Figure 2-17** compares the difference between the reference and assessment scenarios for the Spring Flow Elevation threshold (84 Ml/d), for the representative string water resources years. The 84 Ml/d threshold is achieved every water resources year, the years outside of the wider season are represented in light grey. Water resources years where the threshold is exceeded within the preferred season are presented as the darker colours, with the flows exceeded outside of the preferred season, but still within the wider season presented as lighter colours. There are 17 water resources years (36%) where the reference scenario achieves the threshold in the preferred season, compared to 10 years

(21%) for the assessment scenario. There are longer periods without a flow exceeding the threshold in the preferred season in the assessment scenario with the maximum being 12 years, this is reduced to five years in the reference scenario.

The hydrograph in **Figure 2-18** shows the difference between the flow and storage for the reference and assessment scenarios for each of the different thresholds across an illustrative five year period[28]. In all water resources years, there is greater drawdown in the reservoir in the assessment scenario compared to the reference scenario. This results in the loss of some of the first peak flows of the season and the reduction in the magnitude of some peak flows. Generally peak flows over a threshold are retained in the desired season, with the exception of the AWFE which is observed in the reference scenario in the first water resources year however is not present in the assessment scenario.

**Figure 2-12 Chart showing the years where flow exceeds the threshold for the Small Flood Flow 2 (1,750 Ml/d) for a representative 47 water resources year string for the reference and assessment scenarios.**




[28] Five year sequence has been selected to illustrate a range of scenarios from the 47 hydrological string based on expert judgement.

**Figure 2-13 Chart showing the years where flow exceeds the threshold for the Small Flood Flow 1 (1,500 Ml/d) for a representative 47 water resources year string for the reference and assessment scenarios.**

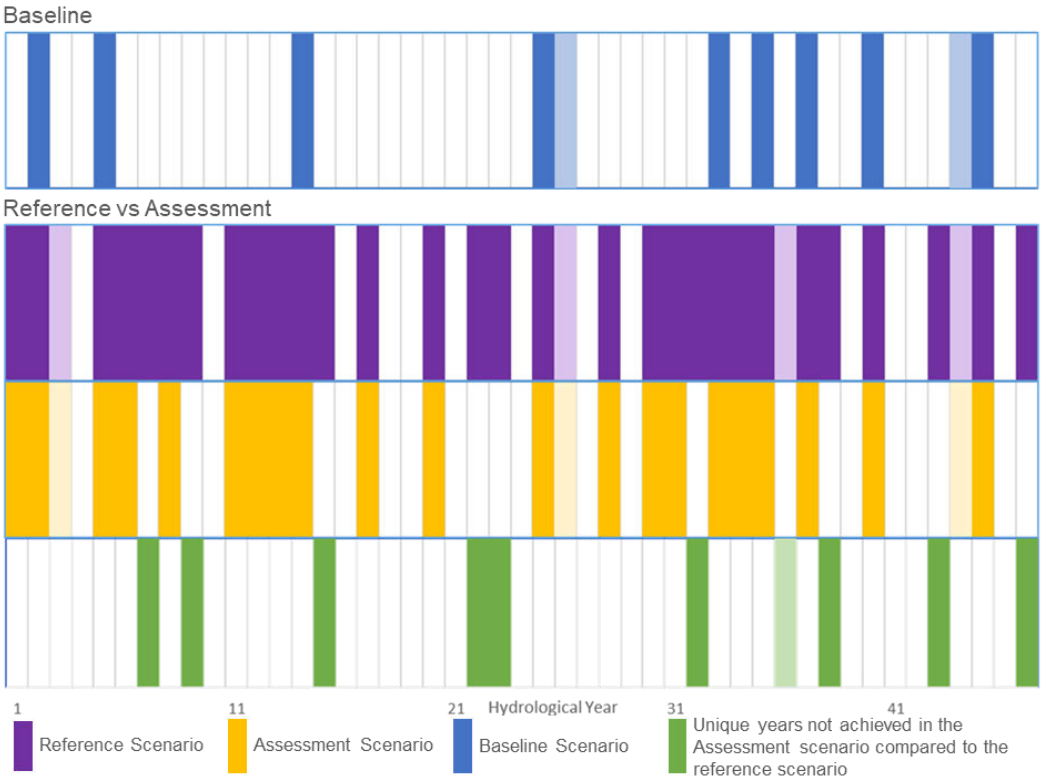



**Figure 2-14 Chart showing the years where flow exceeds the threshold for the Late Summer Flow Elevations (560 Ml/d) for a representative 47 water resources year string for the reference and assessment scenarios.**

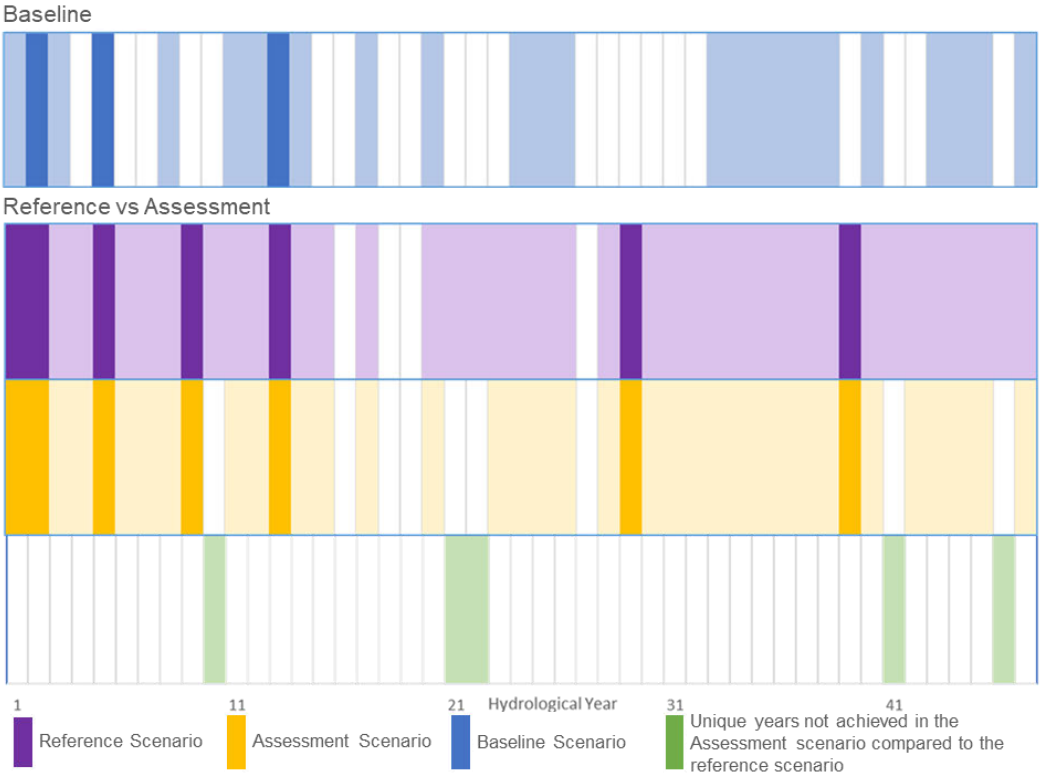


**Figure 2-15 Chart showing the years where flow exceeds the threshold for the Autumn and Winter Flow Elevations (560 Ml/d) for a representative 47 water resources year string for the reference and assessment scenarios. Black indicates that flow is achieved through a managed release.**

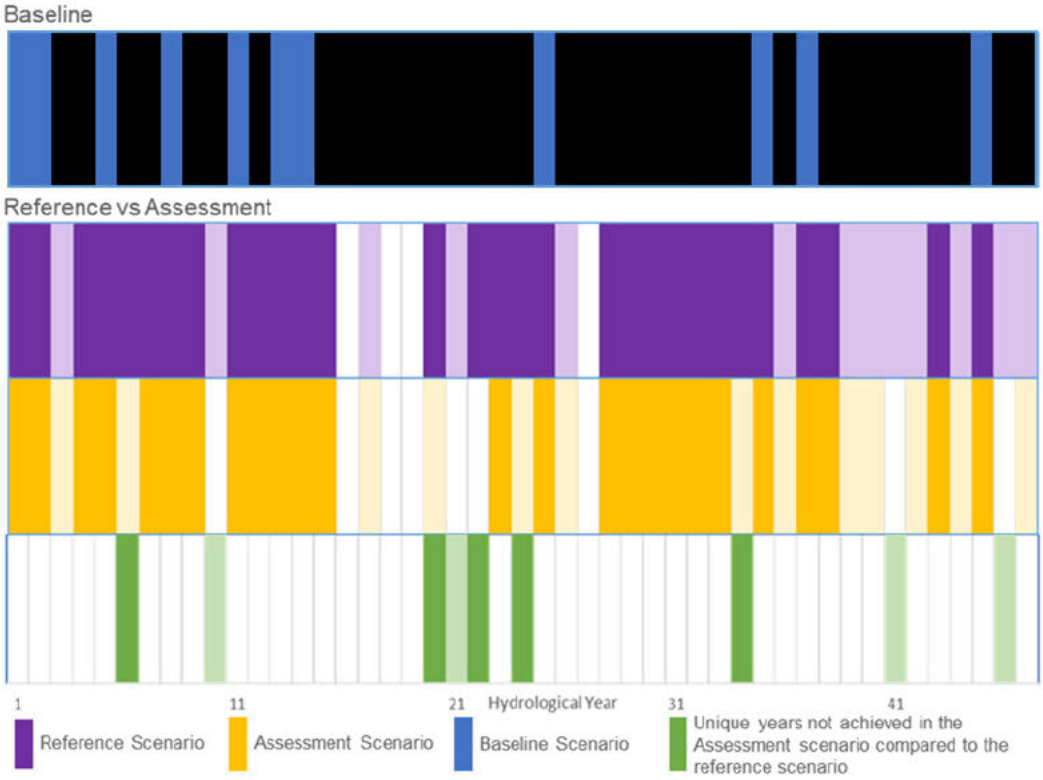



**Figure 2-16 Chart showing the extent of managed releases required to deliver five discrete peaks of 85 Ml/d – 200 Ml/d in the late October to mid December period for adult Atlantic salmon migration, as a component of the AWFE for a representative 47 water resources year string for the baseline and assessment scenarios. Colours indicate that some of the discrete flow elevations are achieved without the need of the S20 waterbank release.**

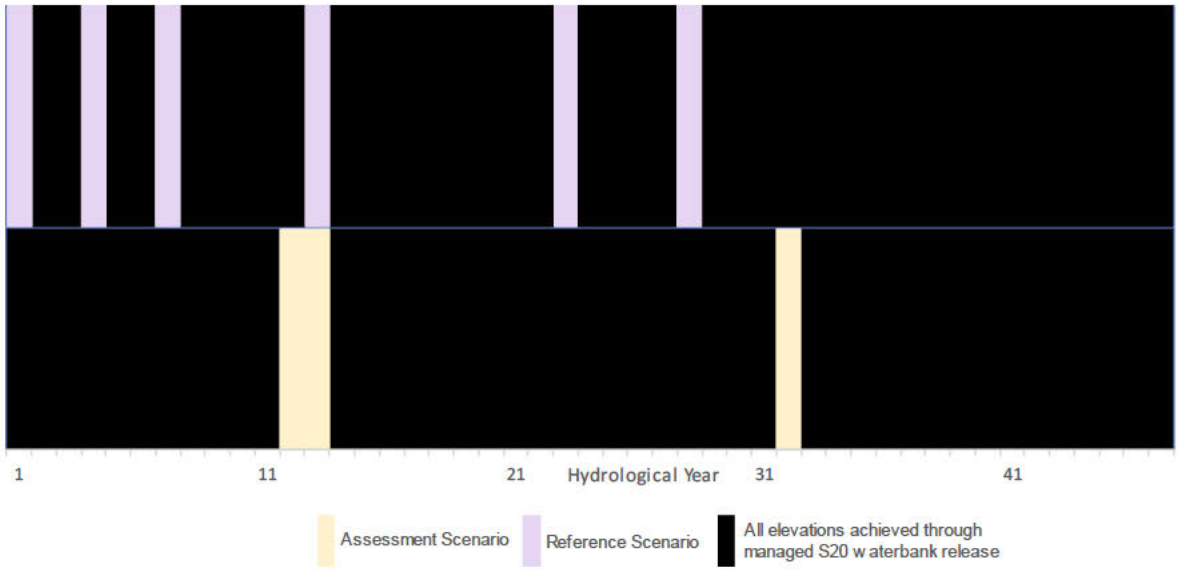


**Figure 2-17 Chart showing the years where flow exceeds the threshold for the Spring Flow Elevation (84 Ml/d) for a representative 47 water resources year string for the reference and assessment scenarios. The dark coloured bars represent flows exceeding the threshold in the preferred season (April-May inclusive), the light-coloured bars represent flows exceeding the threshold outside of the preferred season (March to June inclusive), and the grey bars represent flows exceeding the threshold outside of the season.**

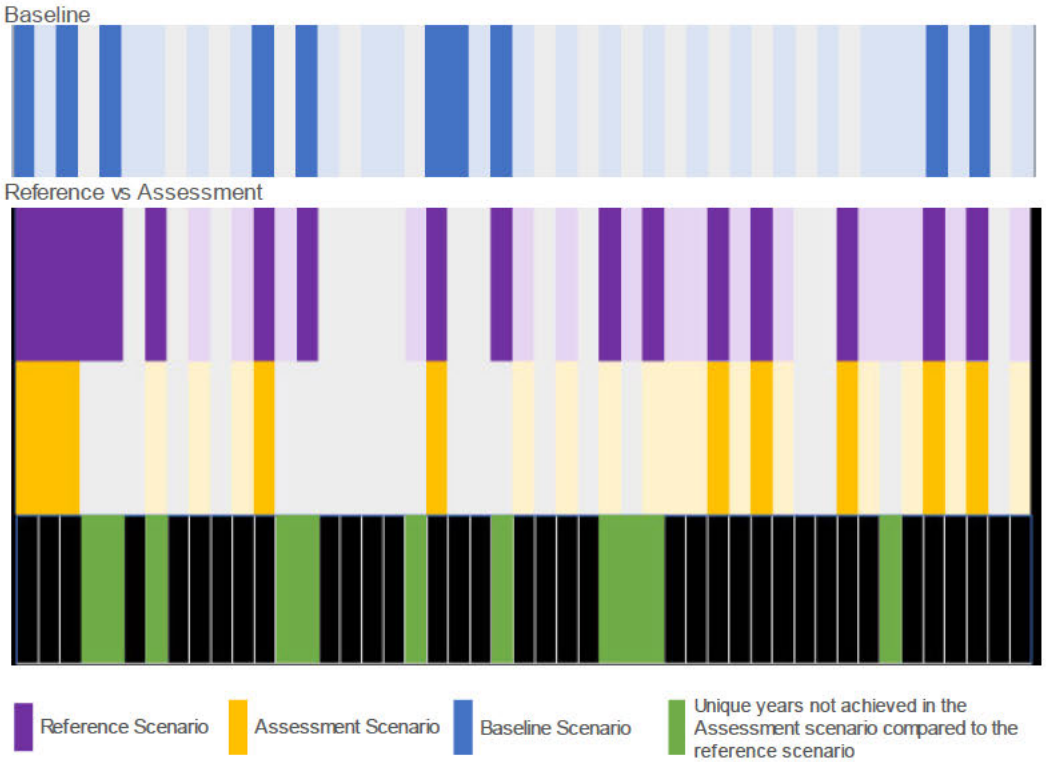
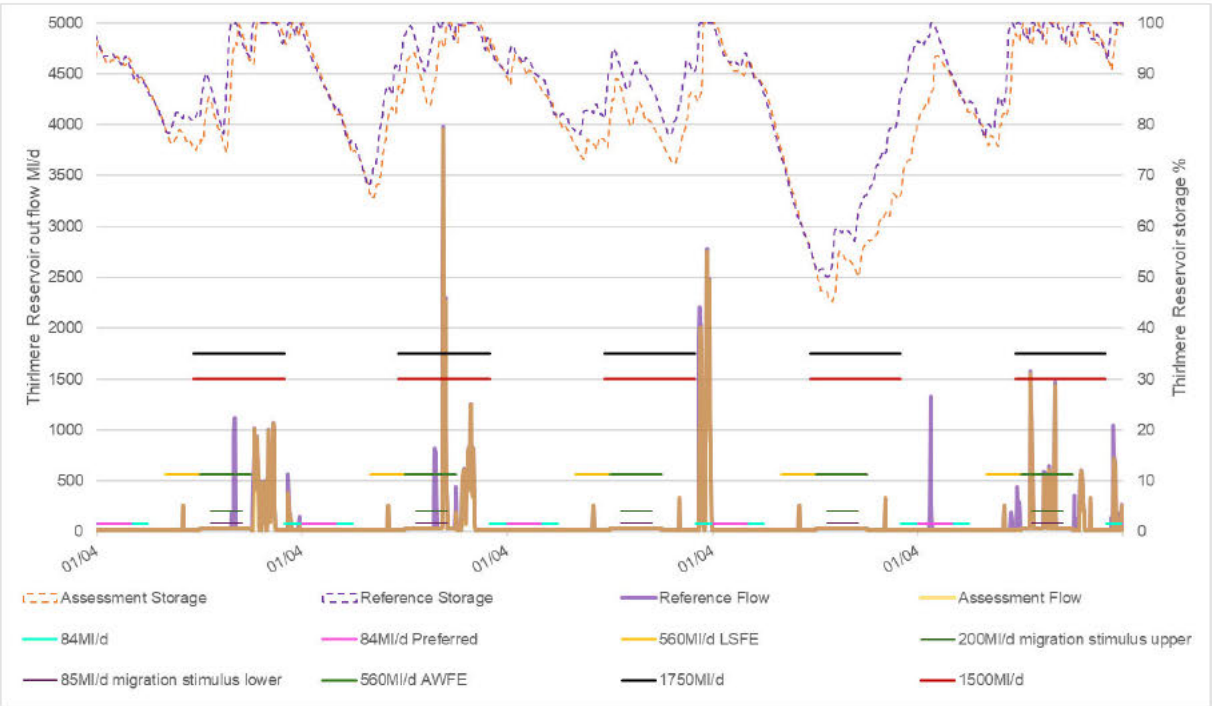



**Figure 2-18 Hydrograph comparing the outflow to St. John's Beck and reservoir storage between the reference scenario and the TTS Only scenario for a selected 5-year period (Year 24 to Year 28). Flow thresholds and desired seasons for each of the building blocks set out in Section 2.1 are included in the figure.**



**Water quality commentary**

Changes in reservoir outflow is a potential pathway to impacting water quality in St. John's Beck, particularly water temperature. The compensation flow and FDD releases are both sourced from the same draw-off from the reservoir, below the thermocline. With these outflows sourced from the same draw-off, the water quality on days where there is only compensation flow compared to days where there is also a FDD release would be identical. As such, when comparing the baseline and assessment scenarios, there is no risk to water quality in St. John's Beck as a result of increasing the number of days that the outflow of Thirlmere is at the compensation flow value.

With the spill water from the reservoir being reservoir surface water, the spill water is likely to be warmer than the water sourced for compensation flow and FDD purposes. As such, a potentially more significant change in water temperature between the baseline and assessment scenario will occur when Thirlmere is spilling in the assessment scenario however the FDD is operational in the baseline scenario (with no spill). The short-term changes in spill between the scenarios described in the sections above are of insufficient duration to cause a change in water temperature between the baseline and assessment scenario. Further, the assessment above has identified that the flow regime in the assessment scenario will move closer to that in the reference scenario compared to the baseline scenario. With the reference scenario is synonymous with the operation of Thirlmere prior to the implementation of the TTS, it can be assumed any changes in water temperature as a result of the assessment scenario will not have a significant effect on the aquatic ecology in St. John's Beck.

**Physical Environment Summary**

Following the assessment of flow changes between the scenarios, the following conclusions can be drawn from the modelled physical environment impacts of the licence renewal:

- The assessment scenario of a like for like abstraction licence renewal including the cessation of the FDD would restore spills of over 1,750 Ml/d to just over a third of modelled water resources years, however not necessarily on a once every three-year basis (as required in the current Section 20 agreement (July 2021)). The reference scenario (i.e. no FDD, no TTS) also fails to result in a spill event of this magnitude on a once every three years basis[29].
- The assessment scenario results in a greater frequency of flows of 560 Ml/d occurring without human intervention compared to the baseline scenario. This reduces the reliance on controlled mitigation releases (see **Section 2.3**). It is also likely to result in reservoir spills coinciding with natural periods of rainfall and wet weather, meaning spills will coincide with greater flow accretion from tributaries in St Johns Beck.
- Despite occurring more frequently than in the baseline scenario, the LSFE and AWFE (560 Ml/d) are not reliably modelled as achieved on a yearly basis with the desired seasonality as part of the assessment scenario. As such, managed releases of this magnitude are still required.

29 Noting that this assessment has considered daily average flows and not instantaneous flows (as required by the current Section 20 agreement).

- Flow rises to stimulate the upstream migration of salmonids are provided predominantly by the Section 20 (2015) waterbank releases across all scenarios.
- There is not expected to be a change in water quality in St. John's Beck as a result of the change from baseline to assessment (i.e. cessation of FDD release).

As set out in **Section 2.1.2**, the regularity requirement for a Small Flood Flow that is set out in the current Section 20 agreement (July 2021) is as set out in the summary table of the UKTAG guidance on the flow building blocks to a river flow regime with Good Ecological Potential which states that the frequency of a flood flow should be "*once every 3 years*" [30]. This frequency is referred to in King *et al* (2008)[31] which scientifically underpins UKTAG guidance, however, this reference also refers to "*Overturning*" flows, understood as the function of the Small Flood Flow, required on "*perhaps once every one to five years*". With a Small Flood Flow as set out by the UKTAG guidance recommendations not achieved on a one in every three year basis in the modelled natural series, it may be that the current frequency requirement for the small flood flow in the Section 20 agreement should not be such a specific target for St. John's Beck.

These conclusions are used to inform the recommended future management of Thirlmere (**Section 2.3**) and the recommendations in the HRA (**Section 3**).

## 2.3 Recommendations

**Section 2** commences with the review of the potential flow requirements for the ecological functioning of St. John's Beck through analysis of a modelled natural flow series and measured geomorphological data (see **Section 2.1**). This defined a range of flow thresholds that provide induce important ecological and geomorphological processes to be tested against for the range of scenarios set out in Section 1.3. The assessment (**Section 2.2**) reviewed the frequency and timing of flows against the flow thresholds between scenarios to identify first the impact that the licence renewal (assessment scenario) would have against the current baseline scenario where both FDD and TTS are operational. Additionally, the assessment scenario was compared against a reference scenario where neither TTS or the FDD were operational to review the impacts that the TTS abstraction from Thirlmere has on the flow regime in St. John's Beck. This section, in line with **Section 2.1**, sets out the recommendations for the operation of Thirlmere to support the license renewal in the framework of the UKTAG guidance on the flow building blocks to a river flow regime with Good Ecological Potential[32]. A summary of recommended annual releases is presented in **Section 2.3.6**.

30 *cf.* Appendix 6: Background to suggested good ecological potential flow criteria in UKTAG (2013) River flow for good ecological potential Final recommendations
31 King et al (2008), Environmental Flow Assessments for Rivers: Manual for the Building Block Methodology (Updated Edition), August 2008, Page 171.
32 *cf.* Appendix 6: Background to suggested good ecological potential flow criteria in UKTAG (2013) River flow for good ecological potential Final recommendations

### 2.3.1 Annual Minimum Flow

As set out in **Section 2.1.1**, the functions of the Annual Minimum Flow are achieved by the current compensation flow from Thirlmere. It is not deemed necessary to reconsider the Annual Minimum Flow further.

### 2.3.2 Small Flood Flow

Two Small Flood Flow values were assessed against in **Section 2.2**: 1,750 Ml/d understood as the current Small Flood Flow requirement; and, 1,500 Ml/d which, through further habitat interventions and sediment management work in the catchment, is likely to provide the functions of a Small Flood Flow.

Against both Small Flood Flow thresholds, the assessment scenario results in an increase in number of flows over the threshold than in the baseline scenario. The assessment scenario results in the reinstatement of more spill events to the flow regime than the baseline scenario, but it is noted that this does not equal the frequency of events of this magnitude modelled in the reference scenario. However, it should also be noted that the reference scenario also fails to achieve flows of the higher threshold (1,750 Ml/d) on a one in every three year basis. As set out in **Section 2.1.2** and **Section 2.2.2**, the one in every three year requirement a flow of Small Flood Flow magnitude is potentially not required for this system.

UU do not have the infrastructure capabilities to release Small Flood Flow magnitude flows from Thirlmere. It may be possible in the future to make larger releases from Thirlmere but this would require significant investment.

There is evidence that habitat restoration delivered in the catchment by the West Cumbria Rivers Trust Site Officer in combination with sediment management activity has served to reduce sediment entrainment thresholds[33] during the time period of implementation of the existing mitigation Section 20 agreement. Noting that UU have committed to funding the West Cumbria Rivers Trust St John's Beck Site Officer to continue delivering catchment interventions until September 2026, it is possible that flow thresholds for sediment movement will continue to reduce. It is recommended that UU continue with ongoing sediment management activities in the St. John's Beck catchment which will contribute to reducing the magnitude of peak flow required to induce the functions of a peak flow.

### 2.3.3 Late summer flow elevations

As presented in **Section 2.1.3** and **Section 2.2.2**, the LSFE are not a function of the natural or reference flow regime for St. John's Beck and the habitat and ecological functions of a LSFE are not absent from St John's Beck[34]. As such, it is not advised that LSFEs are required to support the ecological functioning of St. John's Beck. Managed releases to provide this building block are not required. However, it is

[33] APEM (2025) St John's Beck: Sediment Transport Report, APEM Ref P00018296.
[34] APEM (2021) Thirlmere Release scenarios. Report for United Utilities. APEM Ref P5090

recognised that there is overlap in the timing into the UKTAG seasonality of a LSFE through the management window of the AWFE including September.

### 2.3.4 Autumn and winter flow elevations

**Section 2.1.4** demonstrates that AWFE are present on a, very nearly, annual basis in the natural stochastic record, though (as set out in **Section 2.2.2**) even under the reference scenario, there are water resources years where flows that provide the function of the AWFE would not be achieved.

From the review of the natural stochastic record using the UKTAG guidance, the magnitude of the AWFE is calculated as 280 Ml/d, however, the impactometer data for St. John's Beck indicates that this would be insufficient to provide the geomorphological functions of the AWFEs (*to flush away build-up of fine sediment and/or plant debris lying on the channel bed or at the river margins)*.

**Annual autumn large spate releases**

It is proposed that two releases, each of circa 6.48 $m^3/s$ (560 Ml/d) and for a total of 6 hours each are made in the period September to mid-November annually to provide the geomorphological functions of the AWFEs. It is recommended that these releases are made in close succession to maximise their effectiveness in achieving the geomorphological functions of the AWFE. If possible, these should be targeted to follow high flow events in the catchment.

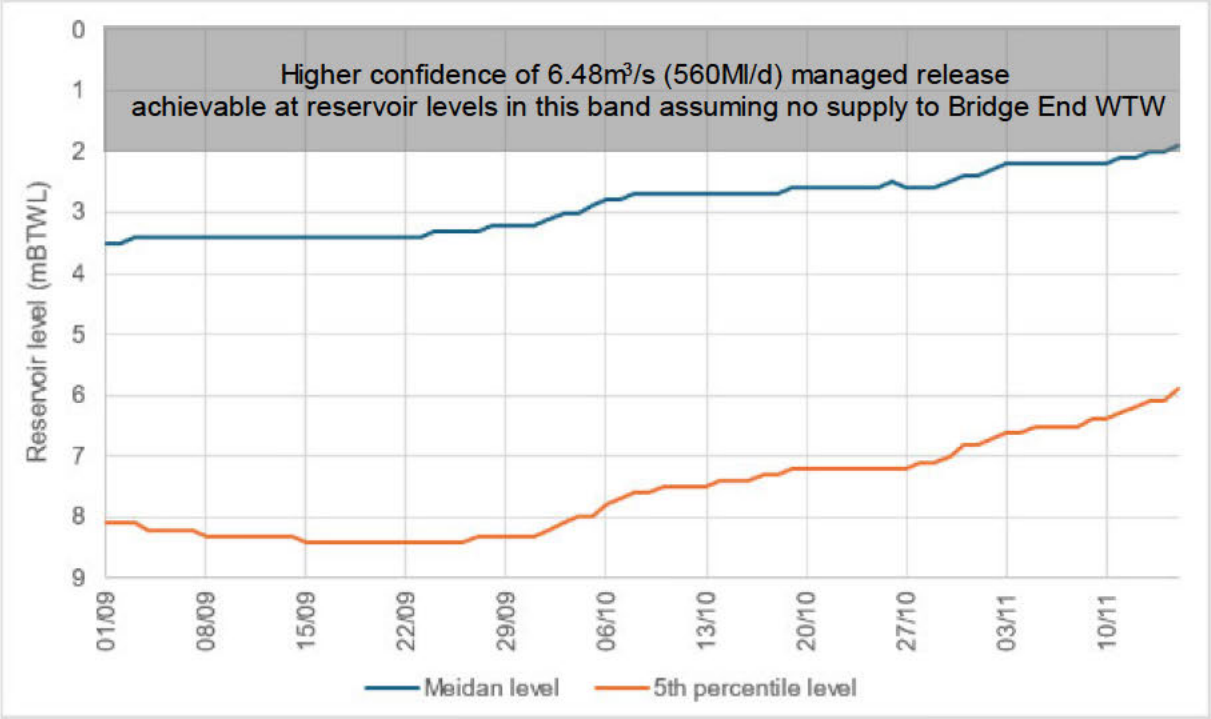
The feasibility of achieving a release of this magnitude is uncertain and varies based on reservoir head. The reservoir level throughout the recommended AWFE period from the stochastic water resources modelling is presented in **Figure 2-19**. As illustrated in **Figure 1-1**, there is no certainty as to the relationship between reservoir level and achievable outflow, however levels of greater than 2m BTWL seem to correspond with instantaneous outflows of greater than 6.48 $m^3/s$. Based on this assumption, the stochastic data indicates that in the median year there would be insufficient head to achieve the 6.48 $m^3/s$ large spate releases throughout the majority of the AWFE period. As $5^{th}$ percentile, the level is always below the likely threshold for achieving releases of 6.48 $m^3/s$ throughout the AWFE period.

This data indicates that it may not always be possible for UU to achieve a specific release value of 6.48 $m^3/s$. It would be sensible to include a condition to stipulate that the maximum achievable rate based on reservoir head when the lower scour valves are opened to their safe operating limit is the suitable rate for this release[35].

It is worth considering that, although making a managed release of 560 Ml/d from the reservoir is not always possible, combined with the opening of the Mill Gill Aqueduct to Howe Beck, the influence of flow from Howe Beck to St. John's Beck may mean that flows exceed this threshold downstream of Howe Beck.

35 Impactometer data supports that, even though the 560 Ml/d is not always achieved, the geomorphological functions are observed.

**Figure 2-19 Thirlmere level throughout the recommended AWFE period based on 19,200 years of stochastic modelled storage data (from the assessment scenario).**




**Fisheries waterbank**

It is advised that these smaller flows are of the magnitude of the current fisheries water bank release (up to 100 Ml/d) is currently effective at providing this function in St. John's Beck for stimulating upstream migration of salmon (see **Section 2.1.4**). The fisheries water bank is not part of the licences being reviewed through the application process, as such, will remain unchanged. Not further mitigation is advised with the fisheries waterbank being sufficient.

### 2.3.5 Spring Flow Elevations

Spring flow elevations, particularly in early spring, are frequently observed in both the natural stochastic record and reference scenario for St. John's Beck (see **Section 2.1.5** and **Section 2.2.2**) though not on an annual basis (or weekly) as advised by the UKTAG guidance building blocks. The magnitude advised by the UKTAG guidance building blocks is likely also insufficient to induce the functions of a Spring Flow Elevation (**Section 2.1.5**).

UU, in collaboration with the Environment Agency, made a 70 Ml/d (in addition to the compensation flow) smolt release in spring 2025. This smolt release was demonstrated as effective with the movement of smolt into a smolt trap in the lower reach of St. John's Beck. As a result, 84 Ml/d is recommended as the magnitude of flow required for a Spring Flow Elevation. This release should be made overnight (from the end of the working day to the morning after), as directed by the Environment Agency during dry weather in the smolt migration season. This will facilitate smolt movement out of St Johns Beck or facilitate smolt trap-and-transport should this be identified as required.

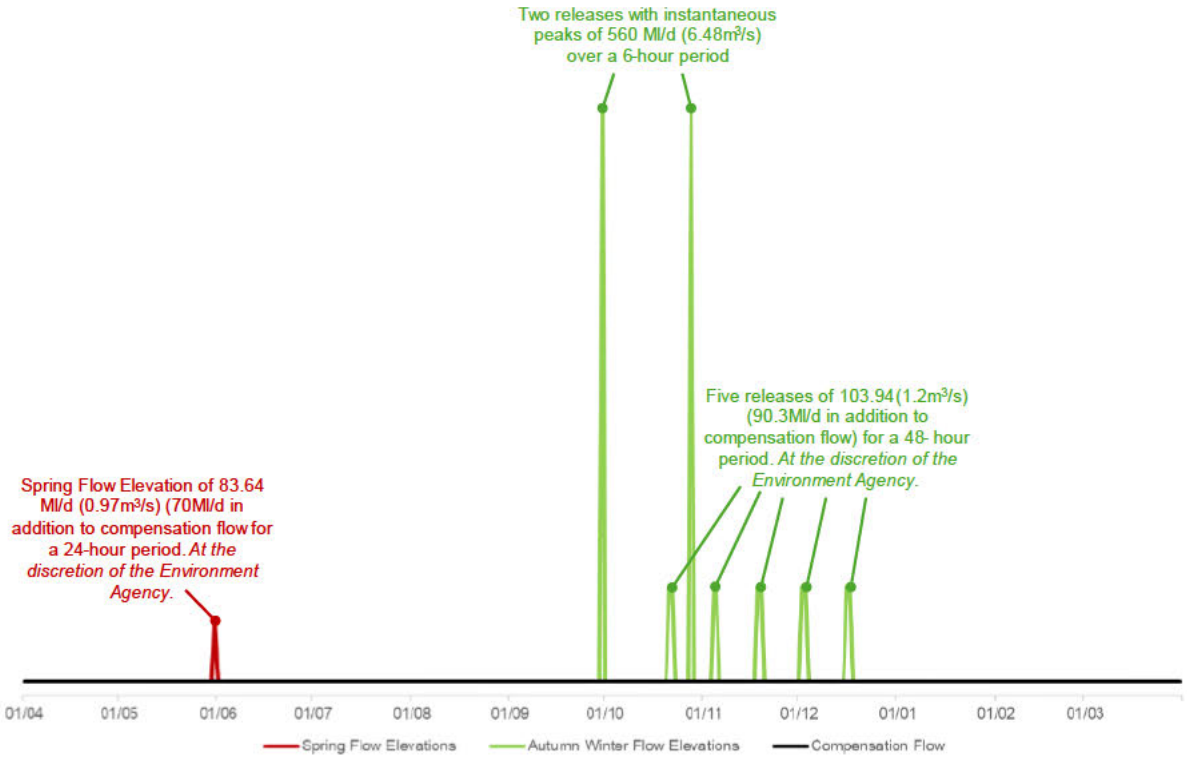
### 2.3.6 Recommendations summary

The sections above present the recommendations for feasible annual releases from Thirlmere to support the ecological functioning of St. John's Beck. The recommendations are summarised in **Table 2-4** and illustrated in **Figure 2-20**, below. It is also recommended that sediment management is also continued in the St. John's Beck catchment to reduce the magnitude of flow required to induce the functions of a Small Flood Flow.

**Table 2-4 Recommendations for annual releases from Thirlmere to support the ecological functioning of St. John's Beck (all magnitude values are inclusive of the compensation flow requirement). The compensation flow arrangements as included in the abstraction licence are not reviewed separately.**

| Release name | Magnitude | Total allocation | Timing | Frequency and duration | Additional comments |
|---|---|---|---|---|---|
| **Autumn and Winter Flow Elevations** | 2x 560 Ml/d (6.48 $m^3/s$) | 400 Ml | September to mid-November | 2 x releases to total 6 hours at maximum release rate<br>Release will be increased to, and reduced from, the maximum release rate at a rate of change not exceeding 2.89 $m^3/s$ per hour (250 Ml/d per hour) | The feasibility of the 6.48 $m^3/s$ magnitude release is uncertain and varies based on reservoir head. As such, the maximum achievable rate based on reservoir head should be released. |
| | 5x 103.94 Ml/d (1.2 $m^3/s$) | 903 Ml | Throughout October to December, inclusive. | 5 x releases, indicated as 48 hours duration. As directed by EA Fisheries Officer | As part of the Section 20 waterbank (2015) allocation. |
| | Open Mill Gill Aqueduct Large Penstock to Howe Beck to provide up to 50 Ml/d (0.57 $m^3/s$) | Up to 2,800 Ml | Between the 3rd week of October and the end of December | For an eight week period | As stipulated in the Section 20 waterbank (2015). |
| **Spring flow elevations** | 84 Ml/d (0.97 $m^3/s$) | 70 Ml | Late April / May to June inclusive. | Once annually. Indicated as 24 hours duration. As directed by EA Fisheries Officer | As already permitted through the Section 20 waterbank (2015) – though not specified in the waterbank guide. |

**Figure 2-20 Illustrative hydrograph of managed releases from Thirlmere to support the ecological functioning of St. John's Beck**



# 3 HABITATS REGULATIONS ASSESSMENT

The requirement for a Habitats Regulations Assessment (HRA) is established through Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, hereby referred to as the 'Habitats Directive', in Articles 6(3) and 6(4). The Habitats Directive is transposed into national legislation by the Conservation of Habitats and Species Regulations 2017 (as amended), commonly referred to as the Habitats Regulations.

Regulations 63 and 64 transposed the provisions of Articles 6(3) and 6(4) of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') as they related to plans or projects in England and Wales.

Regulation 63 states that if a plan or project is "(a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in-combination with other plans or projects); and (b) is not directly connected with or necessary to the management of the site" then the competent authority must "…*make an appropriate assessment of the implications for the site in view of that site's conservation objectives" before the giving consent or authorisation. The plan or project can only be given effect if it can be concluded (following an 'appropriate assessment') that it… will not adversely affect the integrity*" of a site, unless the provisions of Regulation 64 are met.

This assessment process is known as HRA. An HRA determines whether there will be any 'likely significant effects' (LSE) on any European site as a result of a plan's implementation (either on its own or 'in-combination' with other plans or projects) and, if so, whether there will be any 'adverse effects on site integrity'.

## 3.1 Methodology

United Utilities is a 'competent authority' under the Regulations. The Environment Agency is also a competent authority and both parties have a statutory duty to consult with Natural England and have regard to representations made.

An HRA determines whether there will be any 'likely significant effects' (LSE) on any European site as a result of a plan's implementation (either on its own or 'in-combination' with other plans or projects)[36] and, if so, whether there will be any 'adverse effects on site integrity'[37].

Guidance recognises four key steps in the HRA process as follows:

1. Stage 1 Screening – the identification of Likely Significant Effects (LSEs) of a plan or project on a European designated site either alone or in-combination. The test is a trigger for further assessment, and therefore the bar is set low i.e., is there a risk or possibility of an adverse effect. At this stage mitigation measures should not be taken into account, in accordance with the People over Wind (Court of Justice of the European Union (ECJ) Case C-323/17); this

36 Also referred to as the 'test of significance'.
37 Also referred to as the 'integrity test'.

reinforces the idea of screening as a 'low bar' and makes 'appropriate assessments' more common.

2. Stage 2 Appropriate Assessment and the 'integrity test' – which involves closer examination of the project or plan and 'screened in' European designated sites to determine whether those sites will be subject to 'adverse effects on integrity'. The scope of such assessments is not set, and some may not be particularly detailed, especially where standard mitigation measures are available which are known to be effective. The level of assessment must be sufficient to ensure that there is no 'reasonable scientific doubt' that adverse effects on site integrity will not occur.

3. Stage 3 – Alternative Solutions – where adverse effects or uncertainty remain after the inclusion of mitigation in Stage 2, alternative ways where alternative solutions that meet the plan objectives are identified and consideration of their effects are given in comparison to those in the plan. A plan or project which has adverse effects on the integrity of a European site cannot be permitted if alternative solutions are available, except where the criteria for imperative reasons of overriding public interest are met (IROPI, see Stage 4).

4. Stage 4 Imperative Reasons of Overriding Public Interest – where there are no alternatives that have no or lesser effects on European sites, and the IROPI criteria are met, compensatory measures are developed and secured.

The stages as described above, are used to ensure compliance with the Habitats Regulations and so principally reflect the stepwise legislative tests applied to the final, submitted project or plan; there is no statutory requirement for HRA (or its specific stages) to be completed for draft plans or similar developmental stages.

Consequently, there is flexibility for the HRA process to be run in a manner that provides maximum benefit for plan-development and sound decision-making, whilst still ultimately meeting the legislative tests.

### 3.1.1 Guidance

The HRA has been undertaken in accordance with consideration of key guidance and relevant case-practice documents as summarised below:

- Defra (2021). Policy paper: Changes to the Habitats Regulations 2017 [online].
- UK Government (2019). Appropriate assessment: Guidance on the use of Habitats Regulations Assessment [online].
- Tyldesley, D. & Chapman, C. (2021). The Habitats Regulations Assessment Handbook [online]. DTA Publications Limited.
- UK Government (2021). Water resources planning guideline [online].
- UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans.

- Natural England (2020). Guidance on how to use Natural England's Conservation Advice Packages in Environmental Assessments. Natural England, Peterborough.
- European Commission (2018). Managing Natura 2000 sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. European Union, 1-86.
- Defra (2012). The Habitats and Wild Birds Directives in England and its seas: Core guidance for developers, regulators & land/marine managers [online].
- PINS Note 05/2018: Consideration of avoidance and reduction measures in Habitats Regulations Assessment: People over Wind, Peter Sweetman v Coillte Teoranta. [withdrawn].
- SNH (2019). SNH Guidance Note: The handling of mitigation in Habitats Regulations Appraisal – the People Over Wind CJEU judgement [online].

### 3.1.2 Approach to HRA Stage 1 Screening

The objective of the HRA is to establish firstly whether the licence renewal is likely to have a significant effect on European sites (alone or in-combination with other plans and projects). There is no construction stage associated with this project therefore only the operation is to be considered.

The assessment has considered whether there are any LSEs arising from operation of the proposed scheme (either alone or in-combination) on one or more European sites, including Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), as well as internationally designated Ramsar sites:

- SPAs are classified under the European Council Directive 'on the conservation of wild birds' (2009/147/EC; 'Birds Directive') for the protection of wild birds and their habitats (including particularly rare and vulnerable species listed in Annex 1 of the Birds Directive, and migratory species).
- SACs are designated under the Habitats Directive (92/43/EEC) and target particular habitats (Annex 1) and/or species (Annex II) identified as being of European importance.
- The Government also expects, as a matter of policy, potential SPAs (pSPAs), possible/proposed SACs (pSACs), compensation habitat and Ramsar sites to be included within the assessment.
- Ramsar sites support internationally important wetland habitats and are listed under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention, 1971).

For ease of reference throughout the HRA process, these designations will be collectively referred to as "European sites", despite Ramsar designations being made at the international level.

The HRA Stage 1 Screening process will identify whether the 'assessment' scenario (for clarity this is future operation of the TTS without the existing FDD release regime (either alone or in-combination with other plans or projects) is likely to have significant effects on European designated sites. The purpose of the screening stage is to determine whether the project is likely to have a significant effect on any

European site (including areas of compensation habitat, areas of functional land, and the ability for abstractions to occur for the management of designated wetland sites). This is judged in terms of the implications of the plan for a site's conservation objectives, which relate to its 'qualifying features' (i.e. those Annex I habitats, Annex II species, and Annex I bird populations for which it has been designated[38], and Ramsar criterion). Significantly, HRA is based on a rigorous application of the precautionary principle. Where uncertainty or doubt remains, an impact should be assumed, triggering the requirement for Appropriate Assessment of that project.

The screening stage also has to conclude whether any in-combination effects would result from the various schemes within the plan itself, or from implementation of the project in-combination with other plans and projects, and whether these would adversely affect the integrity of a European site.

## Identifying European sites

The initial list of European sites for screening has been derived by adopting a distance-based threshold of 10 km from each option component, plus exceptional, longer impact pathways. The use of a '10 km threshold plus exceptional pathways' approach is based on precedent set for previous HRAs of plans through consultation with statutory consultees and the Impact Risk Zone (IRZ) mapping provided by Natural England for screening of impacts to designated sites in England. It is based on the premise that most significant effects on qualifying species and habitats will occur within a maximum 10 km radius of the source of impact, except where there are exceptional pathways such as major downstream or coastal dispersion effects, or larger foraging and dispersal distances for mobile species (e.g., bats, migratory fish).

In addition, the HRA Stage 1 Screening has identified any habitat outside the designated site that also supports the qualifying species populations that use the European site in question. This off-site 'functionally linked land' (or sea) is particularly relevant to mobile qualifying species (e.g., birds, bats, invertebrates, fish, otters). The precautionary principle applies equally to functionally linked land, so where there is insufficient information to ascertain that there would be no LSE, an Appropriate Assessment will be required. However, this does not mean that every possible parcel of land within reach of the European site's qualifying populations must have been surveyed. The 'Boggis' case[39] establishes that there must be at least credible evidence that there could be a functional link between the location of option effects and the European site.

## Sources of information

Data on the European sites and their interest features has been collected from the Joint Nature Conservation Committee (JNCC) and Natural England websites. These data include information on the attributes of the European sites that contribute to and define their integrity, current conservation status and the specific sensitivities of the site, notably the site boundaries and the boundaries of the component SSSIs; the conservation objectives; the condition , vulnerabilities and sensitivities of the

38 Annexes are contained within the relevant EC Directive.
39 Boggis and Another v Natural England: Court of Appeal, 20 Oct 2009

sites and their interest features; the current pressures and threats for the sites; and the approximate locations of the interest features within each site (if reported); and designated or non-designated 'functional habitats' (if identified).

The following sources of published information were used:

- Site citations.
- Site Register Entries.
- Standard Data Form (SPA/SAC) or Information Sheet (Ramsar site).
- Conservation Objectives and Supplementary Advice on Conservation Objectives (for SPAs/SACs[40]).
- Site Improvement Plans (SIPs).
- Regulation 33 information for European Marine Sites or Conservation Advice for Marine Protected Areas[41].
- Environment Agency Review of Consents information.
- SSSI Impact Risk Zones (in England), which apply equally to European sites.
- Site condition assessment has been integrated with SSSI assessments through Common Standards Monitoring (CSM) and marine condition assessments (for SAC marine features only).
- Definitions of Favourable Conservation Status (where available for species/habitat).
- Favourable Condition Tables are set out for every SSSI that underpins a European site and can often be applicable to the European site's qualifying features.
- Article 12 (SPA) and Article 17 (SAC) status reports.

### Thresholds

The UKWIR guidance[42] includes accepted 'zones of influence' for certain impacts, as repeated in **Table 3-1**, however the best and latest information should always be used to inform an assessment. Where possible, robust universal assumptions regarding the sensitivities of European site interest features will also be specified and applied at screening, for example:

- Most breeding passerines will not be water-resource dependent.
- For groundwater sources and groundwater fed habitats, the Environment Agency consider that significant effects as a result of ground water abstractions are unlikely on European sites over 5 km from the abstraction[43].
- Wide-ranging marine / marine dependent species associated with marine sites that are not directly connected to the hydrological zone of influence are not typically considered to be both

40 The conservation objectives for Ramsar sites are taken to be the same as for the corresponding SACs / SPAs (where sites overlap); SSSI Favourable Condition Tables will be used for those features not covered by SAC/SPA designations.
41 Natural England & the Countryside Council for Wales' advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended.
42 UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans. UK Water Industry Research Limited, London.
43 National Environment Agency guidance: Habitats Directive Stage 2 Review: Water Resources Authorisations – Practical Advice for Agency Water Resources Staff

sensitive and exposed to the effects of the options (except in certain relatively unique circumstances, such as some desalination schemes).

Sites over 10 km from the options that are not hydrologically linked and which do not support wide-ranging mobile species are considered sufficiently remote such that any environmental changes will be effectively nil, and so there will be 'no effects' on sites beyond this distance (and so no possibility of 'in-combination' effects).

**Table 3-1 Potential Impacts of Project Options[44] (Source: UKWIR, 2021)**

| Broad categories of potential impacts on European Sites, with examples | Examples of activities responsible for impacts *(example distance considerations in italics)* |
|---|---|
| Physical loss:<br>• Removal<br>• Smothering | Development of infrastructure associated with option, e.g., new or temporary pipelines, transport infrastructure, temporary weirs.<br>Indirect effects from a reduction in flows e.g., drying out of water-margin habitat.<br>*Physical loss is likely to be significant where the boundary of the option extends within or is directly adjacent to the boundary of the European site, or within/adjacent to an offsite area of known foraging, roosting, breeding habitat (that supports species for which a European site is designated, or where natural processes link the option to the site, such as through hydrological connectivity downstream of an option, long shore drift along the coast, or the option impacts the linking habitat).* |
| Physical damage:<br>• Sedimentation/silting<br>• Prevention of natural processes<br>• Habitat degradation<br>• Erosion<br>• Fragmentation<br>• Severance/barrier effect<br>• Edge effects | Construction activity leading to permanent and/or temporary damage of available habitat, sedimentation/siltation, fragmentation, etc.<br>*Physical damage is likely to be significant where the boundary of the option extends within or is directly adjacent to the boundary of the European site, or within/adjacent to an offsite area of known foraging, roosting, breeding habitat that supports species for which a European site is designated, or where natural processes link the option to the site, such as through hydrological connectivity downstream of an option or sediment drift along the coast.* |
| Non-physical disturbance:<br>• Noise<br>• Visual presence<br>• Human presence<br>• Light pollution | Noise from temporary construction or temporary pumping activities.<br>*Taking into consideration the noise level generated from general building activity (c. 122dB(A)) and considering the lowest noise level identified in appropriate guidance as likely to cause disturbance to estuarine bird species, it is concluded that noise impacts could be significant up to 1 km from the boundary of the European site*[45,46]<br>Noise from vehicular traffic during operation of an option.<br>*Noise from construction traffic is only likely to be significant where the transport route to and from the option is within 3-5 km of the boundary of the European site*[47].<br>Plant and personnel involved in in operation of the option.<br>*These effects (noise, visual/human presence) are only likely to be significant where the boundary of the option extends within or is adjacent to the boundary of the European site, or within/adjacent to an offsite area of known foraging, roosting, breeding habitat (that supports species for which a European Site is designated).* |

44 Note that the distances given in this table are illustrative only and should be defined for each Plan option on a case by case basis.
45 Environment Agency (2013) Bird Disturbance from Flood and Coastal Risk Management Construction Activities. Overarching Interpretive Summary Report. Prepared by Cascade Consulting and Institute of Estuarine and Coastal Studies.
46 Cutts N, Hemingway K and Spencer J (2013) The Waterbird Disturbance Mitigation Toolkit Informing Estuarine Planning and Construction Projects. Produced by the Institute of Estuarine and Coastal Studies (IECS). Version 3.2.
47 British Standards Institute (BSI) (2009) BS5228 - Noise and Vibration Control on Construction and Open Sites. BSI, London.

| Broad categories of potential impacts on European Sites, with examples | Examples of activities responsible for impacts *(example distance considerations in italics)* |
|---|---|
| | Options that might include artificial lighting, e.g., for security around a temporary pumping station.<br>*Effects from light pollution[48] are more likely to be significant where the boundary of the option is within 500 m of the boundary of the European site.* |
| Water table/availability:<br>• Drying<br>• Flooding/stormwater<br>• Changes to surface water levels and flows<br>• Changes in groundwater levels and flows<br>• Changes to coastal water movement | Changes to water levels and flows due to increased water abstraction, reduced storage or reduced flow releases from reservoirs to river systems. Potential for changes to habitat availability, for example reductions in wetted width of rivers leading to desiccation of macrophyte beds.<br>*These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the European site. However, these effects are dependent on hydrological continuity between the option and the European site, and sometimes whether the option is up or down stream from the European site.* |

| Broad categories of potential impacts on European Sites, with examples | Examples of activities responsible for impacts *(example distance considerations in italics)* |
|---|---|
| Toxic contamination:<br>• Water pollution<br>• Soil contamination<br>• Air Pollution | Reduced dilution in downstream or receiving waterbodies due to changes in abstraction or reduced compensation flow releases to river systems.<br>*These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the European Site. However, these effects are dependent on hydrological continuity between the option and the European Site, and sometimes whether the option is up or down stream from the European site.*<br>Air emissions associated with plant and vehicular traffic during construction and operation of options.<br>*The effect of dust is only likely to be significant where site is within or in close proximity to the boundary of the European site[49,50]. Without mitigation, dust and dirt from the construction site may be transported onto the public road network and then deposited/spread by vehicles on roads up to 500 m from large sites, 200 m from medium sites, and 50 m from small sites as measured from the site exit.*<br>*Effects of road traffic emissions from the transport route to be taken by the project traffic are only likely to be significant where the protected site falls within 200 metres of the edge of a road affected[51].* |
| Non-toxic contamination:<br>• Nutrient enrichment (e.g., of soils and water)<br>• Algal blooms<br>• Changes in salinity<br>• Changes in thermal regime<br>• Changes in turbidity<br>• Changes in sedimentation/silting | Changes to water salinity, nutrient levels, turbidity, thermal regime due to increased water abstraction, discharges, storage, or reduced compensation flow releases to river systems.<br>*These effects are only likely to be significant where the boundary of the option extends within the same ground or surface water catchment as the European site. However, these effects are dependent on hydrological continuity between the option and the European site, and sometimes whether the option is up or down stream from the European site.* |
| Biological disturbance:<br>• Direct mortality<br>• Changes to habitat availability<br>• Out-competition by non-native species<br>• Selective extraction of species<br>• Introduction of disease<br>• Rapid population fluctuations | Killing or injury due to construction activity.<br>*Likely to be a risk where the boundary of the option extends within or is directly adjacent to the boundary of the European site, or within/adjacent to an offsite area of known foraging, roosting, breeding habitat (that supports species for which a European site is designated).*<br>Creation of new pathway for spread of non-native invasive species. |

48 Institute of Lighting Professionals (2020) Guidance Notes for the Reduction of Obtrusive Light GN01/20.
49 Highways Agency (2003) Design Manual for Roads and Bridges (DMRB), Volume 11.
50 Institute of Air Quality Management (2014) Guidance on the assessment of dust from demolition and construction v1.1.
51 Natural England Internal Guidance – Approach to Advising Competent Authorities on Road Traffic Emissions and HRAs V1.4 Final - June 2018

| Broad categories of potential impacts on European Sites, with examples | Examples of activities responsible for impacts *(example distance considerations in italics)* |
|---|---|
| • Natural succession | *This effect is only likely to be significant where the option is situated within the European site or an upstream tributary of the European Site, but also for inter-catchment water transfers.* |

### 3.1.3 Approach to Stage 2 Appropriate Assessment

The 'appropriate assessments' are an extension of the assessment processes undertaken at the screening stage, with significant effects (or areas of uncertainty) examined to determine whether there will be any adverse effects on the integrity of any European sites taking into account the conservation objectives. Where an LSE was identified at the screening stage (noting the precautionary principle), an Appropriate Assessment, has been completed.

The Appropriate Assessment has considered the potentially damaging aspects of the proposed scheme operation, and the potential effects on the associated European site's qualifying features and achievement of the conservation objectives and characterised the impacts in terms of their likelihood, nature, scale, severity and duration.

The potential for adverse effects on the integrity of a European site depends on the scale and magnitude of the action and its predicted impacts, taking into account the distribution of the qualifying features across the site in relation to the predicted impact and the location, timing and duration of the proposed activity and the level of understanding of the effect, such as whether it has been recorded before and, based on current ecological knowledge, whether it can be expected to operate at the site in question.

#### Impacts

To determine adverse effect on site integrity (AEoI), the following parameters was used as appropriate to define the impact (i.e., mechanism by which effects are caused):

- Impact type - direct or indirect, positive or negative.
- Magnitude of impact – the 'amount' or intensity of an impact. This may sometimes (but not always) be synonymous with 'extent' (see below) for certain impacts, such as habitat loss.
- Extent of impact – the area over which the impact will be felt.
- Duration of impact – how long it will occur. The guidelines suggest that ecological impact durations should be described in terms of ecological characteristics (e.g. species lifecycles/longevity) rather than human timeframes. The definitions of duration based on this approach and using professional judgement are detailed in
- **Table** 3-2.
- Timing of impact – when it will occur, taking note of seasonality.
- Frequency of impact – how often it will occur.
- Reversibility of impact – whether recovery or reinstatement is possible.

**Table 3-2 Definitions of impact duration**

| Duration | Habitats | Species |
|---|---|---|
| Short-term | The typical regrowth period for many submerged macrophytes, grass and herb communities – as a rough guide, up to two years | Impact is measurable up to one (breeding/wintering, migration, spawning etc.) season – as a rough guide, up to a year for fauna |
| Medium-term | The typical regrowth period for many shrub and hedge communities, slower growing macrophytes and reedbeds – as a rough guide, two to eight years | Impact is measurable up to one typical reproductive lifespan (in the wild). This varies depending on species, but generally anything from one year to 5 years as a rough guide for most fauna |
| Long-term | A period lasting longer than the typical scrub/hedge regrowth period – as a rough guide, more than 8 years | Impact is measurable over several (species) generations |
| Permanent | An impact where no reasonable chance of recovery/restoration is evident within the foreseeable future | |

These impacts then need to be considered in terms of the effects to the qualifying habitats and species.

### Adverse Effect

An AEoI is likely to be one which undermines achievement of the sites conservation objectives and prevents the qualifying feature from progressing towards favourable conservation status.

The Habitats Directive defines the conservation status of habitats as 'favourable' when:

- Its natural range and area it covers within that range are stable or increasing; and
- The species structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future.

The Habitats Directive defines the conservation status of species as 'favourable' when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is neither being reduced for the foreseeable future; and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

### Mitigation measures

The Appropriate Assessment includes consideration of the mitigation measures set out in Section 2.3 (considered here as embedded mitigation), to determine whether any can reduce the likelihood, magnitude, scale, and duration of the effect. The Appropriate Assessment seeks to identify mitigation measures that are practically implementable that will reduce the impact to the lowest level possible, and wherever feasible to avoid adverse effects on site integrity. Mitigation measures can include both avoidance and reduction measures, with the former being the preferred option.

The Appropriate Assessment has assumed that any identified mitigation measures to minimise impacts upon qualifying features and conservation objectives of the designated sites will be embedded within the final specification of the licence renewal.

### Integrity Test

The integrity test is the conclusion of an Appropriate Assessment and requires the competent authority to ascertain whether the proposed scheme (either alone or in-combination with other plans or projects), will have no adverse effect on site integrity. The following definition of site integrity is provided by Defra: the integrity of the site is "*the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the level of populations of the species for which it was classified*"[52].

From the evidence and assessments undertaken, a statement has been made as to whether it can be ascertained that the proposed scheme alone, or in-combination with other plans or projects, will not adversely affect the integrity of a European site. However, it is up to the competent authority to formally undertake this test and record the outcome.

### Limitations

Information provided by third parties, including publicly available information and databases, was considered correct at the time of submission. Due to the dynamic nature of the environment, conditions may change in the period between the preparation of this report, and the licence renewal.

The compilation of information to support an assessment has been undertaken, using available data where they exist. However, the conclusions drawn from this is necessarily limited by the age, type, coverage and availability of data. Any uncertainties and the limitations of the assessment process are acknowledged and highlighted.

## 3.1.4 Review of Potential In-Combination Effects

The HRA process requires that the effects of other projects, plans or programmes be considered for effects on European sites 'in-combination' with the licence renewal. In accordance with the legislation, the following approach will be adopted for the in-combination assessment:

- STEP 1 – Does the Project have no discernible effect, whatsoever, on the European site? If not, then there's no need for in-combination assessment, as logic dictates it can't have in-combination effects.
- STEP 2 - Does the Project, alone, have an adverse effect on the European site? If so, then there's no need for in-combination assessment as consent cannot be given unless the HRA Stages 3 and 4 derogation tests are met, in which case all residual effects of the scheme acting alone will be compensated for.

52Defra Circular 01/2005.

- STEP 3 – Does the Project have a discernible effect, but one which is not 'significant' in the context of the Habitats Regulations (i.e. adverse effect on site integrity) alone? If so, then an in-combination assessment is required.
- STEP 4 – Identify the other Plans/Projects that also have discernible effects that (1) aren't an adverse effect alone but (2) might act in-combination with effects of your Project. It is normal practice to agree this list of potential in-combination Plans/Projects with the Competent Authority before doing the assessment.
- STEP 5 – Assess these other Plans/Projects in-combination with this Project.

## 3.2 HRA Stage 1 Screening

The initial 10 km search boundary has been implemented from the outlet of Thirlmere (NGR: NY 30840 18890), however, exceptional impact pathways including hydrological links have been considered beyond this threshold. From an initial desk-based inventory a number of SACs have been identified that may be associated with the licence renewal, these are displayed in **Table 3-3**.

**Table 3-3 European sites within 10km, or associated with exceptional impact pathways, of the outlet of Thirlmere.**

| European designated site | Screening Criteria |
|---|---|
| Ullswater Oakwoods SAC | The SAC is located 7.5 km East of the Thirlmere outlet. The SAC is not hydrologically linked to Thirlmere. |
| Lake District High Fells SAC | The SAC is a multi-site SAC with three land parcels located 3.5 km East, 6.6 km North and 0.9 km West of Thirlmere outlet. The SAC land parcels are not hydrologically linked to Thirlmere. |
| River Derwent and Bassenthwaite Lake SAC | The SAC encompasses the River Derwent system which passes through two lakes and includes several tributaries including St John's Beck which is hydrologically linked to Thirlmere and begins immediately downstream of the reservoir outlet. |
| Borrowdale Woodland Complex SAC | The SAC is located 3.7 km West of the Thirlmere outlet. The SAC is not hydrologically linked to Thirlmere. |
| River Eden SAC | The SAC is located 7.8 km East of the Thirlmere outlet. The SAC is not hydrologically linked to Thirlmere. |

Of these European designated sites only one has the potential to be impacted by the licence renewals and has been included in HRA Screening, this is the River Derwent and Bassenthwaite Lake SAC. As the changes to the operating regime of Thirlmere will only result in changes to the flow regime downstream of the reservoir, sites without a hydrological link have been have not been considered for further screening assessment due to the absence of an identifiable pathway.

### 3.2.1 Assessment of Likely Significant Effects From The Project

The HRA Screening for LSE to the River Derwent and Bassenthwaite Lake SAC is summarised in **Table 3-4** with identified impact pathways presented in **Table 3-5**. The full screening assessment is provided in Table 3-6. The assessment of likely significant effects are informed and characterised by the physical environment assessment and the 2016 IIAA[3].

The licence renewal changes to the release regime from Thirlmere would result in changes to the flow regime of St. John's Beck and therefore has potential to impact on the qualifying features and overall

conservation objectives of the River Derwent and Bassenthwaite Lake SAC. There is no construction phase related to this project. The 2016 IIAA noted that within the SAC the TTS and FDD in combination only resulted in likely adverse impacts within St. John's Beck.

**Table 3-4 Summary of outcomes of the HRA screening assessment of the licence renewals for potential LSE to the River Derwent and Bassenthwaite SAC**

| Site Name | Qualifying Features | Potential Likely Significant Effect | Potential Likely Significant Effect In-Combination |
|---|---|---|---|
| River Derwent and Bassenthwaite SAC | Habitat 3130: Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea | No | No |
| | Habitat 3260: Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation | Yes | No |
| | Species 1099: River lamprey (*Lampetra fluviatilis*) | Yes | No |
| | Species 1096: Brook lamprey (*Lampetra planeri*) | Yes | No |
| | Species 1106: Atlantic salmon (*Salmo salar*) | Yes | No |
| | Species 1355: Otter (*Lutra lutra*) | Yes | No |
| | Species 1095: Sea lamprey (*Petromyzon marinus*) | No | No |
| | Species 1065: Marsh fritillary butterfly (*Euphydras aurina*) | No | No |
| | Species 1831: Floating water-plantain (*Uranium natans*) | No | No |

**Table 3-5 Identified impact pathways and which qualifying features of the River Derwent and Bassenthwaite Lake SAC they are associated with.**

| | Qualifying feature | | | |
|---|---|---|---|---|
| **Pathway** | Habitat 3260 | Salmon | River lamprey & Brook Lamprey | Otter |
| A change in the magnitude and frequency of high flows in the upper reaches of St. John's Beck and any consequent alteration of the sediment regime | ✓ | ✓ | ✓ | × |
| Changes to marginal habitats due to a change in wetted width and velocities, including a loss of fine sediments. | × | ✓ | ✓ | × |
| Impacts on fish migration and migratory cues within St. John's Beck as a result of the change in flow regime | × | ✓ | ✓ | × |
| Changes in water quality with changes in temperature potentially impacting fish egg incubation periods. | × | ✓ | ✓ | × |
| Changes in food availability (fish) due to a change in flows. | × | × | × | ✓ |
| Increased rates of flooding impacting otter resting sites including holts, couches and natal dens. | × | × | × | ✓ |
| Increased rates of flooding impacting otter resting sites including holts, couches and natal dens. | × | × | × | ✓ |

**Table 3-6 HRA screening assessment of the licence renewal for potential LSE to the River Derwent and Bassenthwaite SAC.**

| Site Name | Qualifying Features | Potential for Effects | Potential Likely Significant Effect | Potential Likely Significant Effect In-Combination |
|---|---|---|---|---|
| **River Derwent and Bassenthwaite SAC** | Habitat 3130: Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea | Habitat 2130 is only present in Bassenthwaite Lake within the SAC. As Bassenthwaite Lake and the habitats it supports were indicated to have negligible impact from the TTS and FDD in combination this habitat was scoped out of the assessment in 2016 and is therefore screened out for impact within this HRA. | No | No |
| | Habitat 3260: Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation | The 2016 IIAA identified potential pathways to impacts to Habitat 3260 as a result of the operational phase of the TTS and FDD in combination, these included:<br>• A reduction in the magnitude and frequency of high flows in St. John's Beck and any consequent alteration of the sediment regime causing a reduction in suitable macrophyte habitat.<br>The 2016 IIAA concluded that whilst a reduction in the magnitude and frequency of high flows, from TTS and FDD in combination, may result in beneficial impacts from an increased wetted width, unmitigated operational activities resulting in changes in flow have the potential to adversely affect this qualifying habitat within the River Derwent and Bassenthwaite Lake SAC through alteration of the sediment regime and a reduced 'cleansing' function within St. John's Beck. This is currently being mitigated through the annual large spate releases associated with the current mitigation Section 20 agreement.<br>The assessment for the effects on this habitat and associated flora as a result of the licence renewal has identified the following impact pathways that may arise from a change in the rate of spill from Thirlmere into St. John's Beck:<br>• A change in the magnitude and frequency of high flows in St. John's Beck the upper reaches of St. John's Beck and any consequential alteration of the sediment regime. | Yes | No |

| Site Name | Qualifying Features | Potential for Effects | Potential Likely Significant Effect | Potential Likely Significant Effect In-Combination |
|---|---|---|---|---|
| | Species 1099: River lamprey (*Lampetra fluviatilis*) | The 2016 IIAA identified the following potential pathways to impacts on river lamprey and brook lamprey as a result of the operational phase of the TTS and FDD in combination:<br>• A reduction in sediment transport and sorting and a resulting reduction in the area of suitable gravel spawning habitat for river lamprey and brook lamprey within St. John's Beck.<br>The 2016 IIAA concluded that a reduction in high flows, from TTS and FDD in combination, was not considered to impact river lamprey and brook lamprey migration and may provide a more stable environment for their juvenile life stages due to a reduction in the frequency and magnitude of high flows.<br>The 2016 IIAA did conclude that a predicted reduction in flood flows may limit the ability of St. John's Beck to perform natural geomorphological processes which may reduce the availability of clean, sorted gravel and cobble substrate which lamprey rely on for spawning, resulting in a potential impact to lamprey recruitment. As a result, it was stated that unmitigated operation of the TTS and FDD could have a significant adverse effect on the lamprey populations within the River Derwent and Bassenthwaite Lake SAC. This is currently being mitigated through the annual large spate releases associated with the current Section 20 agreement.<br>The assessment for effects on river lamprey and brook lamprey as a result of the licence renewal has identified the following impact pathways that may arise from a change in the rate of spill from Thirlmere into St. John's Beck:<br>• A change in the magnitude and frequency of high flows in the upper reaches St. John's Beck and any consequent alteration of the sediment regime.<br>• Changes to juvenile lamprey habitats within margins due to a change in wetted width and velocities, including a loss of fine sediments.<br>• Impacts on upstream migration of adult lamprey to spawning areas.<br>• Changes in water quality with changes in temperature potentially impacting on egg incubation periods. | Yes | No |
| | Species 1096: Brook lamprey (*Lampetra planeri*) | | Yes | No |
| | Species 1106: Atlantic salmon (*Salmo salar*) | The 2016 IIAA identified the following potential pathways to impacts on Atlantic salmon as a result of the operational phase of the TTS and FDD in combination:<br>• A reduction in migration opportunity for adult and smolt-stage Atlantic salmon migrating into, or from, St. John's Beck.<br>• A change in timing / frequency of Atlantic salmon migration cues as a result of decreased levels in Thirlmere and an increase in the period between rainfall and spate flows. | Yes | No |

| Site Name | Qualifying Features | Potential for Effects | Potential Likely Significant Effect | Potential Likely Significant Effect In-Combination |
|---|---|---|---|---|
| | | • A reduction in sediment transport and sorting and a resulting reduction in the area of suitable gravel spawning habitat for Atlantic salmon within St. John's Beck.<br>The 2016 IIAA concluded that an expected reduction in the frequency and magnitude of high flow events in St. John's Beck, from TTS and FDD in combination, has the potential to reduce migration opportunities for Atlantic salmon. Additionally, an increased lag time between rainfall events and flow peaks was considered to result in a reduction of migratory cues causing further loss of migration opportunities, particularly for adult Atlantic salmon. Further to this, the predicted reduction in flood flows may limit the ability of St. John's Beck to perform natural geomorphological processes which may reduce the availability of clean, sorted gravel and cobble substrate which Atlantic salmon rely on for spawning, resulting in a potential impact to Atlantic salmon recruitment. As a result, it was stated that unmitigated operation of the TTS and FDD could have a significant adverse effect on the Atlantic salmon populations within the River Derwent and Bassenthwaite Lake SAC. This is currently being mitigated through the Section 20 fisheries waterbank and the large spate releases associated with the Mitigation Section 20 agreement.<br>The assessment for effects on Atlantic salmon as a result of the licence renewal has identified the following impact pathways that may arise from a change in the rate of spill from Thirlmere into St. John's Beck. The following impact pathways were identified:<br>• A change in the magnitude and frequency of high flows in the upper reaches St. John's Beck and any consequent alteration of the sediment regime.<br>• Impacts on Atlantic salmon migration and migratory cues within St. John's Beck as a result of the change in flow regime.<br>• Changes to juvenile Atlantic salmon habitats within margins due to a change in wetted width and velocities.<br>• Changes in water quality with changes in temperature potentially impacting on egg incubation periods. | | |
| | Species 1355: Otter (*Lutra lutra*) | The 2016 IIAA identified the potential impacts of the operational phase of the TTS and FDD in combination on otter to be limited to a reduction in available food supply in St. John's Beck due to a decrease in the breeding success of fish species. Otter populations in St. John's Beck are currently unknown, therefore as a precaution it was assumed that unmitigated operation of the TTS could have a significant adverse effect on otter populations within the River Derwent and Bassenthwaite Lake SAC due to a reduction in food availability. | Yes | No |

| Site Name | Qualifying Features | Potential for Effects | Potential Likely Significant Effect | Potential Likely Significant Effect In-Combination |
|---|---|---|---|---|
| | | The assessment for the effects on otter as a result of the licence renewal has identified the following impact pathways that may arise from an increased rate of spill from Thirlmere into St. John's Beck:<br>• Changes in food availability (fish) due to a change in flows<br>• Increased rates of flooding impacting otter resting sites including holts, couches and natal dens. | | |
| | Species 1095: Sea lamprey (*Petromyzon marinus)* | Sea lamprey, are not considered to be impacted because the River Derwent and Tributaries SSSI citation suggests that sea lamprey nursery grounds are primarily below Bassenthwaite Lake. This was confirmed by Environment Agency survey data and Rare and Protected Species Database; which returns no confirmed records of sea lamprey upstream of Bassenthwaite Lake. River lamprey have been recorded in the River Greta and brook lamprey are present throughout the majority of the River Derwent catchment and it is considered that unidentified lamprey records upstream of Bassenthwaite Lake represent these two species. Sea lamprey were therefore considered not to be impacted by the changes in operation of Thirlmere because they are not present upstream of Bassenthwaite Lake and therefore are outside the area where operational impacts are likely to occur. This is reinforced by monitoring in St John's Beck carried out by the West Cumbria Rivers Trust[53] in 2021 and 2024 which recorded no sea lamprey within St John's Beck which is considered to be likely due to a lack of optimal habitat and the presence of migration barriers. | No | No |
| | Species 1065: Marsh fritillary butterfly (*Euphydras aurina*) | Changes to the flow regime as a result of operational changes at Thirlmere are not considered to result in LSE to marsh fritillary butterfly as this species is not dependent on the water environment and no work is associated with their terrestrial habitat. The species is therefore not considered to have the potential for LSE. | No | No |
| | Species 1831: Floating water-plantain (*Uranium natans*) | Floating water-plantain, has been screened out for potential LSE as it is primarily concentrated in high-quality habitat in Derwent Water and Bassenthwaite Lake, neither of which were predicted to be impacted by the changes in operation of Thirlmere. | No | No |

53 West Cumbria Rivers Trust (2024) Thirlmere Section 20 Agreement Mitigation Measures. St John's Beck Fisheries Monitoring Survey 2024.

## 3.3 HRA Stage 2 Appropriate Assessment

Screening of LSE (see **Section 3.2**) has identified the requirement for an appropriate assessment of the potential impacts of the Thirlmere abstraction licence on the River Derwent and Bassenthwaite Lake SAC. The River Derwent and Bassenthwaite Lake SAC is a large oligotrophic river system that passes through two natural lakes, Derwent Water and Bassenthwaite Lake. Broad conservation objectives have been set for the River Derwent and Bassenthwaite Lake SAC and these are:

*Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; The extent and distribution of qualifying natural habitats and habitats of qualifying species The structure and function (including typical species) of qualifying natural habitats The structure and function of the habitats of qualifying species The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely The populations of qualifying species The distribution of qualifying species within the site.*

The following features of the SAC and have been screened out for potential LSE, therefore have not been considered further in this report: Habitat 3130: Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea. Species 1065: Marsh fritillary butterfly (*Euphydras aurina*). Species 1095: Sea lamprey (*Petromyzon marinus*). Species 1831: Floating water-plantain (*Luronium natans*). The following features of the SAC have been screened for potential LSE: Habitat 3260: Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation Species 1099: River lamprey (*Lampetra fluviatilis*); Species 1096: Brook lamprey (*Lampetra planeri*); Species 1106: Atlantic salmon (*Salmo salar*); Species 1355: Otter (*Lutra lutra*);

The current status of these habitats and species are discussed in **Section 3.3.1** and assessed in **Section 3.3.2**. The assessment considers the mitigation releases, habitat restoration and sediment management activities set out in **Section 2.3.6**.

### 3.3.1 River Derwent and Bassenthwaite Lake SAC

#### Habitat 3260: Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation

**Habitat Information**

Habitat 3260 is a qualifying feature of the River Derwent and Bassenthwaite Lake SAC, but is not a primary reason for site selection. This habitat type is characterised by the abundance of water-crowfoots Ranunculus species, subgenus *Batrachium* (*Ranunculus fluitans, R. penicillatus subsp. penicillatus, R. penicillatus ssp. pseudofluitans, and R. peltatus* and its hybrids). There are several variants of this habitat in the UK, depending on geology and river type, and the type of callitricho-batrachion (CB) vegetation present in the River Derwent and Bassenthwaite Lake SAC is Sub-type 3. This variant is a

mesotrophic to oligotrophic community found on hard rocks in the north and west. The European Nature Information System (EUNIS). The European Nature Information System (EUNIS) guidance lists the plants associated with this habitat as: *Ranunculus saniculifolius, R. trichophyllus, R. fluitans, R. peltatus, R. penicillatus sp. penicillatus, R. penicillatus sp. pseudofluitans, R. aquatilis, Myriophyllum sp., Callitriche sp., Sium erectum (Berula erecta), Zannichellia palustris, Potamogeton sp.* and *Fontinalis antipyretica*.

This vegetation type tends to occur on base-poor, mesotrophic rivers with upland influences, usually over hard geology, resulting in flashy flow regimes. Substrate typically consists of gravels, pebbles and cobbles with scattered boulders. Plant species diversity at individual reaches may be considerable as a result of the large number of bryophytes present.

The growth of instream vegetation is frequently limited by shading, bed instability or current speed, but *Callitriche hamulata* will thrive in the faster flowing conditions, with *C. stagnalis* in backwaters and margins. Marginal plants are scarce in this habitat type, as sites that are not shaded are often grazed.

Base-poor sites may be vulnerable to acidification, in which case an increase in *Juncus bulbosus* and *Scapania spp*. and loss *of Ranunculus spp.* and *Cinclidotus* (if present) may occur[54].

**Conservation Status**

Overall assessment of conservation status of water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation at the national level is classed as unfavourable – bad however the overall trend in conservation status is classed as improving[55].

The pressures and threats of high importance on habitats of this type within the UK as listed by the Fourth Report by the United Kingdom under Article 17 for the conservation status of H3260 - Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation include:

- Invasive non-native species (INNS)
- Pollution to surface water
- Pollution to ground water
- Modification of hydrological flow
- Physical alteration of water bodies
- Temperature changes due to climate change

**Conservation Objectives**

The objectives for the River Derwent and Bassenthwaite Lake SAC were updated in 2018[56], but only as a set of high-level objectives for the qualifying features of the SAC (see **Section 3.3**). No detailed

54 . Ecology of Watercourses Characterised by Ranunculion fluitantis and Callitricho Batrachion Vegetation. Conserving Natura 2000 Rivers Ecology Series No. 11. English Nature, Peterborough.
55 Joint Nature Conservation Committee. 2019. Fourth Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2013 to December 2018. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17
56 Natural England. 2018. European Site Conservation Objectives for River Derwent and Bassenthwaite Lake Special Area of Conservation Site Code: UK0030032. Published 27 November 2018 (version 3).

supplementary advice is currently available to support these objectives or define favourable conservation status. For this assessment of the abstraction licence, we have therefore drawn on the detailed information in the favourable condition tables that supported the previous consultation draft of the conservation objectives as presented below:

**Vegetation composition:**

- No loss of extent of standing water.
- Presence of at least three of the characteristic Littorelletea species.
- No loss of characteristic species.
- 6 out of 10 vegetated sample spots (boat or wader survey) should include at least one characteristic species.

**Negative indicator species:**

- Non-native species should be absent or present at low frequency.
- Algal dominance: cover of benthic and epiphytic filamentous algae less than 10%.

**Macrophyte community structure:**

- Characteristic zones of vegetation should be present.
- Maximum depth distribution should be maintained.
- At least the present structure should be maintained.
- No loss of marginal vegetation.

**Water Quality:**

- Stable nutrient levels appropriate to lake type. For deep (>3 m) oligotrophic lakes with low alkalinity, such as Derwent Water and Crummock Water: mean annual total phosphorus concentrations less than: 10 ug/l.
- Stable pH/ANC values of 5.50 to circumneutral.
- Adequate dissolved oxygen levels for health of characteristic fauna, Crummock Water minimum dissolved oxygen levels of >4 mg/l within the hypolimnion during summer stratification for Arctic charr.
- No excessive growth of cyanobacteria or green algae.
- No exceedance of EQS for heavy metals. Water transparency, Bed clearly visible: lakes, secchi disk >5 m Hydrology: There should be a natural hydrological regime which maintains the natural flushing rate, seasonal water-level fluctuations and lake residence times.

- Water transparency, Bed clearly visible: lakes, secchi disk >5 m.

**Hydrology:** There should be a natural hydrological regime which maintains the natural flushing rate, seasonal water-level fluctuations and lake residence times.

**Condition Assessment**

In the most recent Condition Assessment, the SAC was largely assessed as being in unfavourable condition (no change). The reasons for the unfavourable condition is diffuse water pollution (increased levels of phosphorous) and the impacts associated with human-induced hydraulic changes[57].

### Species 1099: River lamprey (*Lampetra fluviatilis*) and species 1096: brook lamprey (*Lampetra planeri*)

**Species Information**

River lamprey are found in coastal waters, estuaries and accessible rivers. The species is normally anadromous (i.e. spawning in freshwater but completing part of its life cycle in the sea), and pollution or artificial obstacles such as weirs or dams impede migration.

Brook lamprey are a non-migratory freshwater species, occurring in streams and occasionally in lakes in north-west Europe. Like other lamprey species, the brook lamprey requires clean gravel beds for spawning and soft marginal silt or sand for the ammocoete larvae.

Unusually high flows can have a detrimental effect on migratory species such as lamprey by making it harder to travel upstream or by damaging breeding grounds or washing eggs downstream. However, very low flows and in-river structures can also impede fish passage through shallow areas or result in sedimentation of breeding grounds which can suffocate eggs[58].

**Table 3-7 Lamprey habitat requirements[59].**

| Species | Spawning Habitat | | Nursery Habitat | |
|---|---|---|---|---|
| | Substrate | Water Depth | Substrate | Water Depth |
| Lamprey | Well oxygenated gravel-pebble dominated 15-110 mm | 20-150 cm River and sea lamprey typically spawn in deeper water than brook lamprey although in larger rivers brook lamprey also spawn in deep water | Open structured, aerated, silty-sandy substrates. Emergent vegetation stabilises substrate and increases suitability. | Optimally 2-40 cm and typically less than 50 cm. In deeper water, up to 220 cm, sea lamprey likely to dominate. |

The River Derwent and tributaries provide important spawning and nursery habitat for sea lamprey, river lamprey and brook lamprey and internationally important populations of these species are present within the region.

There are extensive sea and river lamprey nursery grounds below Bassenthwaite Lake on the River Derwent. Juvenile brook lamprey are also found on the lower river although their distribution is more

57 Natural England river Derwent and tributaries SSSI unit condition assessment 2023 – Accessed June 2025: https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S2000214&ReportTitle=RIVER%20DERWENT%20AND%20TRIBUTARIES.
58 Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.
59 Natural England (2009) Conservation objectives and definitions of favourable condition for designated features of interest: River Derwent and Bassenthwaite Lake SAC, Consultation Draft

localised. Nursery grounds of river and brook lampreys also occur between Derwent Water and Bassenthwaite Lake and on the River Cocker below Buttermere[60].

**Conservation Status**

Overall assessment of conservation status for river lamprey at the national level is classed as favourable however the overall trend in conservation status is classed as unknown[61]. For brook lamprey the overall assessment of conservation status at the national level is classed as unknown.

The pressures and threats of high importance on habitats of this type within the UK as listed by the Fourth Report by the United Kingdom under Article 17 for both river lamprey and brook lamprey include:

- Pollution to surface water
- Pollution to ground water

**Conservation Objectives**

The objectives for the River Derwent and Bassenthwaite Lake SAC were updated in 2018, but only as a set of high-level objectives for the qualifying features of the SAC (see Section 3.3). No detailed supplementary advice is currently available to support these objectives or define favourable conservation status. For this assessment we have therefore drawn on the detailed information in the favourable condition tables that supported the previous consultation draft of the conservation objectives[62] as presented below:

**Population targets:**

For age structure in populations of *Lampetra sp*. (i.e. brook lamprey and river lamprey) ammocoetes, at least two distinct size classes should normally be present in samples of 50 or less. If more than 50 ammocoetes are collected, at least three size classes should be present. Lamprey should be present at not less than 2/3 of sites surveyed across the catchment. As a minimum, there should be no reduction in the distribution of ammocoetes within the catchment. Ammocoete density of *Lampetra sp.* in optimal habitat should be >10 per square metre.

**Condition Assessment**

In the most recent Condition Assessment, the SAC was largely assessed as being in unfavourable condition (no change) with comments around lamprey stating[63]:

*Brook, River and Sea Lamprey: The CSM guidance for rivers states that the condition of the notified species should be the same as the supporting habitat. For this unit, the river is in unfavourable condition*

60 Natural England: River Derwent and Tributaries SSSI citation. Available from: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/2000214.pdf
61 Joint Nature Conservation Committee. 2019. Fourth Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2013 to December 2018. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17
62 Natural England (2011) Conservation objectives and definitions of favourable condition for designated features of interest: River Derwent and Bassenthwaite Lake Consultation Draft, dated 20th July 2011.
63 Natural England river Derwent and tributaries SSSI unit condition assessment 2023 – Accessed June 2025: https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S2000214&ReportTitle=RIVER%20DERWENT%20AND%20TRIBUTARIES.

*due to modified geomorphology, therefore the lamprey features are also unfavourable. There are also barriers present which hinder the migration of sea and river lamprey.*

### Species 1106: Atlantic salmon (*Salmo salar*)

**Species Information**

Atlantic salmon are anadromous fish which utilise rivers for reproduction and as nursery areas for young fish. Young Atlantic salmon (alevin, fry and parr) spend between one and six years in freshwater environments before migrating to the sea as 'smolts' to mature into adult fish. After one to three years in the sea, Atlantic salmon return to rivers to spawn in autumn or winter in excavated depressions in the river substrate called 'redds'.

Upstream migration of Atlantic salmon primarily occurs at higher river flows, and is typically triggered by increases in flow[31]. Low flows can impede Atlantic salmon movement up rivers during migration by creating areas too shallow for fish to pass through. Movement of Atlantic salmon can also be obstructed by in-river structures which either create a physical barrier during unsuitable flow conditions.

Atlantic salmon spawning takes place in shallow excavations called redds, found in shallow gravelly areas in clean rivers and streams where the water flows swiftly and oxygen levels are high. The young that emerge disperse into other parts of the river. After a period of 1-6 years the young Atlantic salmon migrate downstream to the sea as 'smolts'. Adult Atlantic salmon have a homing instinct that draws them back to spawn in the river of their birth after 1-3 years in the sea. This behaviour has resulted in genetically distinct stock between rivers and even within individual rivers, with some evidence of further genetic distinctiveness in the tributaries of large rivers. This is an important consideration for conservation purposes.

**Table 3-8 Atlantic salmon habitat requirements[64].**

| Spawning Habitat | | Nursery and Juvenile Habitat | | Adult Habitat |
|---|---|---|---|---|
| **Substrate** | **Water depth** | **Substrate** | **Water depth** | **Water depth** |
| Stable pebble-cobble substrate, not compacted, 16-256 mm with majority <150 mm | 10-75 cm<br>NB for the Review of Consents the Environment Agency used the preferred depth of 10 cm and 0.25 $cm^3$/sec for juvenile salmon | Pebble, cobble and gravel | <20 cm for fry<br>20-40 cm for parr | >1.5 m depth Pools with cover such as undercut banks, vegetation, submerged objects and surface turbulence |

**Conservation Status**

Overall assessment of conservation status for Atlantic salmon at the national level is classed as unfavourable (inadequate) however the overall trend in conservation status is classed as stable.

64 Natural England (2009) Conservation objectives and definitions of favourable condition for designated features of interest: River Derwent and Bassenthwaite Lake SAC, Consultation Draft

The pressures and threats of high importance on habitats of this type within the UK as listed by the Fourth Report by the United Kingdom under Article 17 for Atlantic salmon include:

- Management of fish stocks and game
- Introduction and spread of species in marine aquaculture
- Physical alteration of water bodies
- Temperature changes due to climate change
- Changes in precipitation due to climate change

The principal tributaries for Atlantic salmon spawning and nursery grounds in the River Derwent and Bassenthwaite Lake SAC are the Rivers Greta, Glenderamackin and Marron as well as St John's, Naddle, Whit and Sandy Becks. The Greta-Glenderamackin, with its tributaries St John's and Naddle Becks, act as the prime Atlantic salmon fry and parr production area in the Upper Derwent catchment[65].

Following reassessment in 2022 Atlantic salmon were reclassified from 'Least Concern' to 'Endangered' in 2023 in Great Britain under the IUCN Red List[66]. Within Cefas's 2023 salmon stocks and fisheries assessment the Derwent is currently classified as 'At Risk' (<5% probability of meeting the management objective) and the predicted classification for 2028 is 'At Risk' (<5% probability of meeting the management objective)[67].

**Conservation Objectives**

The objectives for the River Derwent and Bassenthwaite Lake SAC were updated in 2014, but only as a set of high level objectives for the qualifying features of the SAC (see Section 3.3). No detailed supplementary advice is currently available to support these objectives or define favourable conservation status. For this assessment of the Proposed Scheme, we have therefore drawn on the detailed information in the favourable condition tables that supported the previous consultation draft of the conservation objectives[68] as presented below:

- Adult Atlantic salmon run meeting Minimum Biological Acceptable Level for 4 years out of 5 at a sub-catchment level.
- The management target is 5.77 million eggs/annum. maintenance of the multi-sea-winter component.
- Juvenile population densities should not differ significantly from those expected for the river type/reach under conditions of high physical and chemical quality.

65 Natural England: River Derwent and Tributaries SSSI citation. Available from: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/2000214.pdf
66 Darwall, W.R.T. & Noble, R.A. 2023. Salmo salar (Great Britain subpopulation). The IUCN Red List of Threatened Species 2023: https://www.iucnredlist.org/species/213546282/213546288 Accessed on June 2025.
67 Cefas. 2024. Annual Assessment of Salmon Stocks and Fisheries in England and Wales 2023. Preliminary assessment prepared for ICES, March 2024.
68 Natural England (2011) Conservation objectives and definitions of favourable condition for designated features of interest: River Derwent and Bassenthwaite Lake Consultation Draft, dated 20th July 2011.

**Condition Assessment**

In the most recent Condition Assessment, the SAC was largely assessed as being in unfavourable condition (no change) with comments around Atlantic salmon stating:

*Salmon: Environment Agency data from 2019, using data up to 2018 shows that the Conservation Limit and egg deposition estimates have not been met for 4 years out of the last 5 years, therefore salmon are in unfavourable condition. Furthermore, the trajectory for egg deposition estimates is in decline. In 2023 (using 2013-2022 final catch data), the Environment Agency have classified the salmon stocks in the River Derwent SSSI/SAC as at risk. Whilst part of the decline will be due to issues at sea (which are being looked at in the national 5-point salmon plan), there are nevertheless issues that are affecting salmon in this site. There are manmade physical barriers to salmon migration where the fish passes are not adequate, preventing salmon reaching their spawning grounds. This is particularly the case at Yearl Weir, which is a major barrier to fish passage at the bottom of the catchment. Even where the barriers are passable there are multiple barriers where passage is possible but difficult, or not passable in certain flow conditions, then condition of the salmon will deteriorate and there is likely to be reduced spawning success. Barriers are also hindering downstream migration of smolt. Environment Agency electrofishing data for the whole catchment shows that fry and parr numbers have generally declined over time and are below long term averages. In addition key attributes of the river are in unfavourable condition. The river in this unit has been modified in many reaches with bank protection, flood embankments and channel straightening resulting in sub-optimal conditions for both spawning and the variety of morphological features such as pools being present for parr and fry. The wild salmon populations are threatened by interbreeding with escaped farmed salmon.*

## Species 1355: Otter (*Lutra lutra*)

**Species Information**

The otter is a semi-aquatic mammal which feeds primarily on fish, crustaceans, amphibians and small mammals.

Throughout most of their range in Europe the diet of otters in fresh water is dominated by fish. Amphibia and crayfish may also form a substantial proportion of the diet in some areas, though their significance varies seasonally, crayfish being taken mainly in the summer and frogs usually in winter and spring[69]. Otters feed on a wide variety of fish species and will take a range of sizes. The size or species of fish predated on is most closely related to relative abundance of the prey present.

Studies suggest that, on average, an individual otter needs to harvest approximately 5 g of fish per $m^2$ of its home range in order to survive. Consequently, it can be assumed that rivers with an annual productivity above 5 g/$m^2$/year should support otters, but those with a lower level would not[70].

69 Chanin P (2003). Ecology of the European Otter. Conserving Natura 2000 Rivers Ecology Series No. 10. English Nature, Peterborough.
70 Chanin P (2003). *Ecology of the European Otter Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough

In addition to fish populations, otters are also dependant on the presence of bankside vegetation for resting and breeding locations. This includes dense scrub, steep wooded banks with exposed roots and boles within riverbanks. Otters are strongly associated with freshwater and for feeding and traveling throughout their range as they follow riparian corridors to commute between foraging areas.

In Cumbria, otters are widely distributed in main rivers and lakes with a concentration on the north-west coast where they have primarily re-colonised from the north. Otters can have a home range of up to 40 km[71]. Key habitats in Cumbria noted as important for otters include rivers, semi-natural woodland (particularly wet woodland), fen, marsh and swamp, and lakes, ponds and tarns[72].

**Conservation Status**

The most recent Environment Agency West Cumbria Otter Survey from 2010[73] (completed as part of the 5th national otter survey) indicated positive records from 40% of 18 sites surveyed, which is up from 5% of sites in 2000/02. There was a clear increase in positive signs in the south-west and central upland areas of West Cumbria. The 6th national otter survey was completed in 2022-2023 however has yet to be published.

[redacted]

**Conservation Objectives**

The objectives for the River Derwent and Bassenthwaite Lake SAC were updated in 2014, but only as a set of high level objectives for the qualifying features of the SAC (see Section 3.3). No detailed supplementary advice is currently available to support these objectives or define favourable conservation status. For this assessment of the Proposed Scheme, we have therefore drawn on the detailed information in the favourable condition tables that supported the previous consultation draft of the conservation objectives[75] as presented below:

**Population density and distribution:**

Population size of otter maintained or increasing. The Environment Agency three-year survey shows otter to be present on all parts of the catchment.

**Anthropogenic mortality:**

Otter populations not significantly impacted by human induced kills.

71 Natural England, Angling Trust and the Environment Agency. Otters – The Facts. http://www.bruno-broughton.co.uk/pdf/Otters_the_fact
72 Cumbria Biological Data Network (2010). Otter (*Lutra lutra*). http://www.cbdc.org.uk/uploads/cbeb/statements/CBEB-Otter.pdf
73 Environment Agency (2010) 5th Otter Survey of England 2009 – 2010: Technical Report
74 https://nbnatlas.org/
75 Natural England (2011) Conservation objectives and definitions of favourable condition for designated features of interest: River Derwent and Bassenthwaite Lake Consultation Draft, dated 20th July 2011.

**Condition Assessment**

In the most recent Condition Assessment, the SAC was largely assessed as being in unfavourable condition (no change). There is no publicly available data to understand whether the above conservation objectives for this species is currently being met and so a condition assessment cannot be made.

### 3.3.2 River Derwent and Bassenthwaite Lake SAC Assessment

The assessment of the abstraction licence renewal focuses on the impact pathways that may arise from a change in the magnitude, frequency and timing of spill from Thirlmere into St. John's Beck. Considering the baseline fish community and the operational pattern, this could result in changes in water quality, hydrology and hydraulics (in-stream habitat). The following impact pathways were identified as a result:

- A change in the magnitude and frequency of high flows in the upper reaches of St. John's Beck and any consequent alteration of the sediment regime.
- Changes to marginal habitat due to a change in wetted width and velocities, including a loss of fine sediments.
- Impacts on fish migration and migratory cues within St. John's Beck as a result of a change in flow regime.
- Changes in water quality with changes in temperature potentially impacting fish egg incubation periods.
- Changes in food availability (fish) due to a change in flows.
- Increased rates of flooding impacting otter resting sites including holts, couches and natal dens.

The impact pathways have been assessed by comparing the assessment and baseline scenario flows to the reference scenario flows outlined in **Section 2.2.2**. This has identified how spill regimes from Thirlmere would change and how the flow regime differs against flow thresholds that have been identified as driving important geomorphological and ecological processes in St. John's Beck (**Section 2.1**). As discussed in **Section 2.2.2** the assessment predicts that the licence renewal would cause the hydrological processes within St. John's Beck to become more aligned with the reference scenario (where neither the FDD or TTS are operational) resulting in the high flow thresholds identified being important for ecological functioning to be more readily achievable within St. John's Beck. This has been used to assess the impact on the features of the River Derwent and Bassenthwaite Lake SAC within St. John's Beck.

#### Habitat 3260: Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation

As set out in **Table 3-5** the potential impacts on this habitat and associated flora identified as a result of the licence renewal at Thirlmere include:

- A change in the magnitude and frequency of high flows in the upper reaches of St. John's Beck and any consequent alteration of the sediment regime.

The existing macrophyte community which makes up this qualifying habitat is considered to be capable of thriving in a range of flow conditions[76] and so a change in river flow regime as a result of the proposed licence renewal is considered unlikely to change the community composition. The licence renewal brings the spill rates closer to the reference scenario and does not introduce more high flow events than the reference scenario, therefore it is not considered that the increase in higher flows will adversely affect this habitat.

The licence renewal is modelled to result in an increase of flows from Thirlmere into St. John's Beck exceeding thresholds for movement of substrate within St. John's Beck (noting the assessment did not consider managed releases exceeding any thresholds). This would increase the ingress of gravels, pebbles and finer materials into the channel through the erosion of the riverbanks and bed resulting in an increase of suitable substrate for macrophyte growth. Additionally, this would cause an increase of the 'cleansing' function whereby high and moderate flows remove any build-up of filamentous algae and fine sediments already present on the channel bed; and algae and epiphytes growing on submerged plants. An increase in this 'cleansing' function would benefit macrophytes, especially slow-growing species which are generally prone to being smothered by algae.

It is concluded that the licence renewal would likely have negligible negative impact on this qualifying habitat and would bring the flow in St John's Beck closer to the reference scenario.

### Species 1099: River lamprey (*Lampetra fluviatilis*) and species 1096: brook lamprey (*Lampetra planeri*)

As set out in **Table 3-5** the potential impacts on river lamprey and brook lamprey identified as a result of the licence renewal at Thirlmere include:

- A change in the magnitude and frequency of high flows in the upper reaches St. John's Beck and any consequent alteration of the sediment regime.
- Changes to juvenile lamprey habitats within margins due to a change in wetted width and velocities, including a loss of fine sediments.
- Impacts on upstream migration of adult lamprey to spawning areas.
- Changes in water quality with changes in temperature potentially impacting on egg incubation periods.

Environment Agency lamprey data for St. John's Beck available is limited to records of unidentified and unmeasured individuals in some years over the period 2015 – 2025. However, monitoring carried out by West Cumbria Rivers Trust in St John's Beck in 2021 and 2023[77] shows lamprey as present throughout St John's Beck with improvements in larval lamprey density from 2021 to 2024. In addition to lamprey records there is significant information available on the habitat preferences of these species,

76 Hatton-Ellis TW & Grieve N (2003). *Ecology of Watercourses Characterised by Ranunculion fluitantis and Callitricho-Batrachion Vegetation*. Conserving Natura 2000 Rivers Ecology Series No. 11. English Nature, Peterborough.
77 West Cumbria Rivers Trust (2024) Thirlmere Section 20 Agreement Mitigation Measures. St John's Beck Fisheries Monitoring Survey 2024.

including flow requirements[78]. Moreover, the available evidence in scientific literature suggests the upstream migration of adult lamprey and the downstream drift of larvae post-spawning tend to have little correlation with flow, provided minimum low flows are available. The compensation flow from Thirlmere is assumed to provide this suitable minimum low flow in St. John's Beck and does not change between scenarios (including the reference scenario). As a result, the modelled increase of flow peaks associated with the licence renewal is not considered to affect lamprey migration.

The licence renewal is modelled to result in a potential increase of, unmanaged, flows from Thirlmere into St. John's Beck exceeding flow thresholds for movement of substrate within St. John's Beck. This would improve the ability of St. John's Beck to perform natural geomorphological processes such as transporting and sorting fine sediment, gravel and cobble substrate. Lamprey species rely on clean, sorted gravels for spawning, therefore, the increased ability of St. John's Beck to undertake these geomorphological processes would likely improve spawning success and recruitment for juvenile lamprey.

Juvenile lamprey are susceptible to high flows because gravel nests and areas of marginal silt are vulnerable to erosion and resuspension as flows increase with subsequent wash-out of larvae. As a result of the modelled increase in higher flows due to the licence renewal may lead to the displacement of juvenile lamprey and washout of their habitats. However, the licence renewal brings the flow regime closer to the reference scenario and does not introduce more high flow events than the reference scenario, therefore it is not considered that the increase in higher flows will adversely affect lamprey.

The potential increased frequency and magnitude of spill from Thirlmere as a result of the licence renewal may impact water quality within St. John's Beck, particularly temperature. However, as per the water quality commentary in Section 2.2.2**,** the licence renewal would bring the spill rates closer to the reference scenario (assumed to be the No LSE scenario) and does not introduce more high flow events than the reference scenario, therefore it is not considered to adversely affect the water temperature regime within St. John's Beck.

It has been concluded in this assessment that the licence renewal would help mitigate against the effects of the TTS and FDD in combination identified in 2016 by improving the ability of St. John's Beck to perform important geomorphological processes which would likely improve spawning success and recruitment for juvenile lamprey. It is also noted that the spill regime of Thirlmere would be closer to the reference scenario flows, the assumed No LSE scenario, as a result of the licence renewal, therefore it is concluded that the increase in flow would not adversely affect lamprey.

### Species 1106: Atlantic salmon (*Salmo salar*)

As set out in Table 3-5 the potential impacts on Atlantic salmon identified as a result of the licence renewal on Thirlmere include:

78 Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No.5. English Nature, Peterborough.

- A change in the magnitude and frequency of high flows in the upper reaches St. John's Beck and any consequent alteration of the sediment regime.
- Impacts on Atlantic salmon migration and migratory cues within St. John's Beck as a result of the change in flow regime.
- Changes to juvenile Atlantic salmon habitats within margins due to a change in wetted width and velocities.
- Changes in water quality with changes in temperature potentially impacting on egg incubation periods.

The aim of the FDD is to reduce the flood peak from Thirlmere and to delay the flood peak from St John's Beck into the River Greta. This increase in the lag time between rainfall events and flow peaks is considered to result in a reduction of migratory cues causing a loss of migration opportunities, particularly for adult Atlantic salmon. By ceasing the FDD regime at Thirlmere, the phasing of the flow peaks would be resynchronised and the magnitude and frequency of higher flows is predicted to increase. This would result in stronger migratory cues for Atlantic salmon that are intrinsically linked to rainfall events and would therefore improve migration opportunity for salmon within St. John's Beck. Downstream smolt migration is not considered to be impacted.

The licence renewal (and ceasing FDD releases) is modelled to result in an increase of flows from Thirlmere into St. John's Beck exceeding 360 Ml/d, 560 Ml/d and 1,750 Ml/d which have been identified as thresholds for movement of substrate within St. John's Beck. This would improve the ability of St. John's Beck to perform natural geomorphological processes such as transporting and sorting gravel and cobble substrate. Atlantic salmon rely on clean, sorted gravels for spawning therefore the increased ability of St. John's Beck to undertake these geomorphological processes would likely improve spawning success and recruitment for juvenile Atlantic salmon.

Juvenile Atlantic salmon are susceptible to high flows with high flows potentially displacing the juveniles due to increases in velocities and depth in the marginal habitats. Though the licence renewal would increase the frequency and magnitude of high flow events in St. John's Beck, it would also bring the flow regime closer to the reference scenario and would not introduce more high flow events than the reference scenario. As a result, it is not considered that the increase in higher flows will adversely affect juvenile Atlantic salmon.

The potential increased rate of spill from Thirlmere as a result of the licence renewal may impact water quality within St. John's Beck, particularly temperature. However, as set out in the water quality commentary in Section 2.2.2, the licence renewal and ceasing reservoir level based FDD releases brings the spill regime closer to the reference scenario and does not introduce more high flow events than the reference scenario. As a result, it is not considered that the licence renewal would adversely affect the water temperature regime within St. John's Beck and, therefore, impact Atlantic salmon egg incubation.

It has been concluded in the assessment that the increase in spill events as a result of the licence renewal would improve migratory cues for adult Atlantic salmon and the ability of St. John's Beck to

perform important geomorphological processes which would likely improve spawning success and recruitment for juvenile Atlantic salmon. The annual autumn large spate mitigation releases fisheries and water bank mitigation releases (as set out in **Section 2.3.4**) would also contribute to enhancing the spawning success and recruitment for juvenile Atlantic salmon. It is also noted that as the spill regime of Thirlmere would be closer to the reference scenario , as a result of the licence renewal, therefore it is unlikely the increase in flow would adversely affect juvenile Atlantic salmon.

### Species 1355: Otter (*Lutra lutra*)

As set out in **Table 3-5** the potential impacts on Otter identified as a result of the licence renewal include.

- Changes in food availability (fish) due to a change in flow.
- Increased rates of flooding impacting otter resting sites including holts, couches and natal dens.

Changes to the flow regime as a result of the licence renewal may impact fish communities within St. John's Beck which could lead to disruptions in the food chain for otter. However, as discussed in the sections above, the licence renewal would bring the spill regime of Thirlmere closer to the reference scenario, as a result fish communities are not considered to be adversely affected.

The increased magnitude and frequency of spill as a result of the licence renewal could impact otter through increased levels of flooding potentially effecting otter resting sites including holts, couches and natal dens. The licence renewal would bring the spill rates closer to the reference scenario and does not introduce more high flow events than the reference scenario, therefore it is not considered that the increase in higher flows will adversely affect otter.

## 3.3.3 Mitigation

As assessed in **Section 3.3.3** the licence renewal would bring the spill rates of Thirlmere closer to the reference scenario and does not introduce more high flow events than the reference scenario, therefore it is not considered that the increase in higher flows will adversely the River Derwent and Bassenthwaite Lake SAC and will likely result in a positive influence. As a result no further mitigation is required, however, the licence renewal is insufficient to restore the flow regime to that of the reference scenario, there remains the need for flow release mitigation measures to ensure sufficient diversity and regularity of high flow events in St. John's Beck. The recommended mitigation measures are presented in **Section 2.3**.

It is advised that annual fisheries monitoring should be carried out on the existing site in St Johns Beck in line with the current mitigation Section 20 monitoring for at least five years in order to understand long-term trends and changes populations. This should be agreed with the Environment Agency and Natural England with consultation of the West Cumbria Rivers Trust.

### 3.3.4 Assessment Conclusion

The potential impacts that could arise as a result of the licence renewal on the qualifying features (with the exception of oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea, marsh fritillary butterfly and sea lamprey) is likely to be related to projected changes in frequency, duration and magnitude of high and peak flow events in St John's Beck.

The assessment has generally identified positive impacts on the qualifying features associated with the licence renewal, with greater magnitude and frequency of high flows improving the geomorphological functioning of St. John's Beck. It was identified that the potential increase in flows as a result of the licence renewal could lead to displacement of juvenile lamprey and Atlantic salmon and result in increased flooding affecting otter rest sites, however it was concluded that, as the predicted spill rates would be closer to the reference scenario and do not introduce more high flow events than the reference scenario, it is not considered that the licence renewal would result in further adverse effects than the reference scenario to these features. There remains the need for flow release mitigation measures to ensure sufficient diversity and regularity of high flow events in St. John's Beck. These are specified in Table 2.2 and include; fisheries waterbank releases for smolt and adult fish migration, annual autumn large sate flow events. These mitigation releases have been included in this assessment.

### 3.3.5 In-combination Effects

The above assessment has demonstrated that the licence renewal with its associated mitigation (Table 2.2), will not have any significant adverse effects on the River Derwent and Bassenthwaite Lake SAC in respect of its conservation objectives and overall integrity. HRA process also requires an assessment of any other plans or projects that may have adverse effects on the SAC, when acting in-combination with the Proposed Scheme. The potential for the TTS abstraction license renewal to have in-combination effects on the River Derwent and Bassenthwaite Lake SAC with other plans and projects has been considered, as set out in **Table 3-9**.

However, as it is noted that the licence renewal will bring the spill rate of Thirlmere closer to the reference scenario and will overall result in a positive influence on the SAC by shifting the flow within St John's Beck towards a more natural regime. Therefore, it is not anticipated the project will have any negative in-combination effects with other schemes. This includes the eight transfer licences which are discussed in **Section 3.3.7.**

**Table 3-9 Assessment of potential in-combination effects of the Thirlmere Transfer Scheme licence renewal.**

| Plan or Project | Potential for In-Combination effects | Further Consideration Required? (Yes/No) |
|---|---|---|
| **Thirlmere Resilience Project** | Thirlmere Resilience is a UU habitat restoration project to improve the water quality entering Thirlmere Reservoir. The project includes peat restoration, changes to stock management including types and numbers of livestock and | No |

| Plan or Project | Potential for In-Combination effects | Further Consideration Required? (Yes/No) |
|---|---|---|
| | temperate rainforest restoration. This is an ongoing project that started in AMP7, is running through AMP8 and will continue through into AMP9. Works associated with the project are upstream of Thirlmere reservoir.<br>The project is expected to have positive impacts on water quality entering the reservoir and therefore, positive effects on water entering St Johns Beck. No hydrological impacts are anticipated. Therefore, it is predicted there will be no negative in-combination effects but may result in positive in-combination effects. | |
| **Resilient Glenderamackin landscape recovery project** | This project proposal has been developed by West Cumbria Rivers Trust. At time of writing it has not been confirmed that the project has been successful in its bid for funding.<br>The overall project aims to re-naturalise 5km of river, improve the condition of soils and grasslands, create 59 hectares of new woodland, create 673 hectares of scrub, create 419 hectares of Wood Pasture, create and restore 90 hectares of ponds and wetlands, plant 2.6km bunded floodplain hedges and 22km 'normal' hedges and restore 360 hectares of peat[79]. St Johns Beck is within the wider catchment where works are anticipated.<br>Should it be funded and implemented in the future, the project is anticipated to have benefits to the River Derwent and Bassenthwaite Lake SAC, through restoring natural processes and improving habitats for designated features of the site. Therefore, it is predicted there will be no negative in-combination effects but may result in positive in-combination effects. | No |
| **Future Flood Releases** | UU have committed to working with the EA to develop a future forecast driven operating regime of releases for Thirlmere reservoir. This regime will be developed following the completion of Environment Agency flood modelling which at time of writing is understood to have been initiated. However, at time of writing, no such operating regime is available for assessment and operational mechanisms for delivery or operating principles have not been identified.<br>When agreed in the future, this regime should be assessed appropriately under the Habitats Regulations in-combination with the nine Thirlmere abstraction licences and any other relevant plans or projects. It is anticipated that should any such regime have potential impacts on the River Derwent and Tributaries SAC it would not be progressed by the EA. | No |
| [redacted] | [redacted] | No |

[79] https://www.westcumbriariverstrust.org/projects/glenderamackin

| Plan or Project | Potential for In-Combination effects | Further Consideration Required? (Yes/No) |
|---|---|---|
| | [redacted] | |
| **Potential Highways culvert improvements for sediment delivery at Sandbed Gill and Fornside Gill (on B5322).** | At time of writing, it is not known if this project will be taken forward and funded by Cumberland Council.<br>These projects, if progressed, should aim to improve sediment conveyance from tributaries of St Johns Beck to the river and therefore, should themselves have positive impacts, and therefore a positive in-combination impact. | No |
| [redacted] | [redacted] | No |
| **Scour valve testing** | This relates to the testing of reservoir safety infrastructure in line with statutory reservoir safety requirements. The volume of water released during scour tests is small and will not impact spill frequency. It should be noted that the USVs at Thirlmere are currently tested 'blind' i.e. the valves are in line and exercised in turn, so only the small volume of water between the valves is released. As such this is considered a neutral in-combination effect. | No |

### 3.3.6 Integrity Test

It is considered from the assessment presented here, that there will be no likely significant effects, either alone or in combination, on the Conservation Objectives or the qualifying features of the River Derwent and Bassenthwaite SAC and thus no significant adverse effect on the site integrity of the SAC as it is assessed that the licence renewal would bring the flows more in line with the reference scenario.

### 3.3.7 Transfer licences

Thirlmere and its associated aqueducts to supply water to Manchester were constructed in the late 1800s. The reservoir not only collects water from upstream of the dam but also from key tributaries which would otherwise flow into St John's Beck downstream of the dam wall by means of the Mill Gill aqueduct (built in the 1920s). This intercepted flow is directed back into the reservoir by gravity. Prior to the Environment Agency Habitats Directive Review of Consents, the abstractions from these streams

were not licenced but were permitted under various parliamentary Acts, commencing with the Manchester Corporation Waterworks Act 1879.

The 2006 Habitats Directive Review of Consents report[80] concluded that:

*"The interception of key tributaries downstream of the reservoir is judged to have a detrimental effect on the SAC species as the aqueduct:*

- *contributes to reducing the availability of suitable migration flows in St John's Beck;*
- *causes the tributaries to dry up downstream, reducing potential SAC habitat;*
- *intercepts and diverts the natural gravel supply from St John's Beck; and*
- *reduces the natural flow variability in St John's Beck."*

In 2009 the Site Action Plan[81] recommended that:

*"Both licences need to be changed in order to conclude no adverse impact on site integrity:*

- *provide a prescribed flow of 3 Ml/d for Helvellyn Gill*
- *provision of a waterbank of 973 Ml/year to provide spates (50 Ml/d for Helvellyn Gill and 113-114 Ml/d for St John's Beck)*
- *gravel management agreement.*

In 2009 a capital project to enable delivery of the prescribed and spate flow to the downstream reaches of Howe Beck was completed and has been operated since winter 2009.

Following this, abstraction licences were issued in 2015 for the eight (previously unlicenced) transfers at Helvellyn Gill, tributaries of Howe Beck, Fisherplace Gill, Sty Beck / Stannah Gill, Ladknott Gill, Mill Gill, Black Gill and tributaries of St John's Beck. Two Section 20 agreements were also signed in 2015; a sediment management agreement and the fisheries waterbank agreement. Both agreements are designed to mitigate for the eight transfer licences impact on flows and sediment transport. The three measures recommended by the 2009 Site Action Plan are therefore all in place.

The Environment Agency undertook an extensive monitoring programme for several *Restoring Sustainable Abstraction* schemes in 2010 to 2018, and this included sites on Helvellyn Gill. The report concluded that fish analysis showed a clear benefit to salmonid populations in the upper reaches of Helvellyn Gill and some benefit in the lower reaches[82]. It is noted that the A591 road culvert does form a barrier to salmon migration on this watercourse.

UU has funded a site officer for St Johns Beck, hosted by West Cumbria Rivers Trust from September 2021 as part of the Section 20 Mitigation agreement (referred to in **Section 1**). The site officer has carried out a series of catchment interventions to improve sediment mobilisation and transport. In 2022 works were undertaken to introduce river gravels six locations to enhance spawning habitat, placement of large boulders have been placed in the stream in clusters to encourage localised scour and provide

[80] Environment Agency (2006) Habitats Directive Review Of Abstraction Licences Stage 3 Appropriate Assessment: Thirlmere Reservoir Version 3 02/02/06
[81] Environment Agency (2009) River Derwent and Bassenthwaite Lake SAC: Site Action Plan – March 2009.
[82] Environment Agency (2020) Restoring Sustainable Abstraction 10 year monitoring programme draft report (unpublished)

cover for fish, mechanical disturbance of a fossilised channel downstream of the Mill Gill aqueduct (Black Gill) to expose a source of buried sediment, with the intention that the sediment will be mobilised into the How Beck when the aqueduct overtops into the gill and removal of a 5m culvert from a tributary of the Howe Beck to allow fish better access to a backwater habitat.

Further fisheries monitoring has been undertaken in the period 2022-2024 by West Cumbria Rivers Trust. Atlantic salmon fry density for St John's Beck (average density across survey sites) was categorised as 'Excellent' under the NFCS for 2024, an improvement on 'Good' status in 2022 and 2023. The improvement NFCS status is the result of considerably higher salmon fry densities in St John's Beck in 2024. Densities of salmon fry were also considerably higher in the How Beck in 2024.

The sediment management plan was recently reviewed with UU, the Environment Agency and Natural England at a meeting and site visit held on 20 March 2025. Recommendations made have been incorporated into sediment management works being undertaken in 2025. The next annual review will be in March 2026.

In addition, the West Cumbria Rivers Trust site officer is currently developing plans for further interventions on Howe Beck including works including watercourse realignment downstream of the A591 crossing at Stybeck Farm, which will result in improved river-floodplain connectivity, sediment connectivity and in-channel habitat and interventions to ease fish passage through the A591 culvert (which is a barrier to fish movement). This includes raising of the water level downstream of the concrete apron through the addition of boulders and installation of cobbles to the concrete apron to increase surface roughness and flow complexity. These measures are funded by UU and are planned to be implemented before the Site Officer role concludes in September 2026[83].

**Summary**

The impacts of the eight transfers identified in the 2006 Review of Consents report are mitigated by the implementation of the prescribed flow, the migration flows and the sediment management plan which were specified in the 2009 Site Action Plan. These measures are working effectively which is demonstrated by the improved numbers of fish in the watercourse in the Environment Agency and West Cumbria Rivers Trust monitoring data from the period 2010 to 2024.

In addition, significant habitat, sediment mobilisation and fish passage improvements have been made in Howe Beck by the West Cumbria Rivers Trust St Johns Beck Site Officer. This is above and beyond the actions recommended in the 2009 Site Action Plan.

It is therefore concluded that mitigation measures for the eight transfer licences are in place and have been demonstrated to be effective and there are No Likely Significant Effects on site integrity as a result of any of the eight transfer licences.

[83] West Cumbria Rivers Trust /UU Section 20 Habitat Improvement Action Plan. Developed in consultation with the Environment Agency and Natural England .

### 3.3.8 Assessment of linked licences relevant to this assessment

1) Thirlmere Reservoir licence no. 27 75 009 011
   - Assessment of impact in-combination with other licences: **None**
   - Assessment of impact alone: **None**
2) Helvellyn Gill licence no. NW/075/0009/004
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
3) Tributaries of Helvellyn Gill licence no. NW/075/0009/005
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
4) Fisherplace Gill licence no. NW/075/0009/006
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
5) Sty Beck / Stannah Gill licence no. NW/075/0009/007
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
6) Ladknott Gill licence no. NW/075/0009/008
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
7) Mill Gill licence no. NW/075/0009/009
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
8) Tributaries of St John’s Beck licence no. NW/075/0009/010
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**
9) Black Gill licence no. NW/075/0009/011
   - Assessment of impact alone: **None**
   - Assessment of impact in-combination with other licences: **None**

# 4 CONCLUSIONS

This report provides an environmental assessment and HRA to support the renewal of the Thirlmere Abstraction Licence Serial No. 27 75 009 011 and eight transfer licences from tributaries (Helvellyn Gill, tributaries of Howe Beck, Fisherplace Gill, Sty Beck / Stannah Gill, Ladknott Gill, Mill Gill, Black Gill and tributaries of St John's Beck. The application is to retain all licences on a like for like basis, including in the Thirlmere licence. Further to supporting the licence renewal, this report looks to provide updated recommendations of suitable flow release regimes to mitigate for any residual impacts of abstraction within the licence on SAC designated features.

The assessment has advised on the potential flow requirements for the ecological functioning of St. John's Beck through review of a modelled natural flow series and measured geomorphological data (See **Section 2.1**). This defined a range of flow thresholds that provide induce important ecological and geomorphological processes to be tested against for the range of operational scenarios. The assessment (**Section 2.2**) reviewed the frequency and timing of flows against the flow thresholds between scenarios to identify, first, the impact that the licence renewal (assessment scenario) would have against the current baseline scenario where both reservoir level based FDD and TTS are operational. Secondly, the assessment scenario was compared against a reference scenario where neither TTS or the current FDD were operational to review the impacts that the TTS abstraction from Thirlmere has on the flow regime in St. John's Beck.

Following the assessment of flow changes between the scenarios, the following conclusions can be drawn over the modelled physical environment impacts of the licence renewal at Thirlmere:

- The licence renewal, including cessation of the reservoir level based FDD, would restore spills of over 1,750 Ml/d to just over a third of modelled water resources years, however not necessarily on a once every three-year basis (as required in the current Section 20 agreement (July 2021)). It should be noted that the reference scenario also fails to result in a spill event of this magnitude on a once every three years basis[84].
- The scenario of the licence renewal results in a greater frequency of flows of 560 Ml/d (daily equivalent) occurring without human intervention compared to the baseline scenario. This reduces the reliance on controlled mitigation releases (see **Section 2.3**).
- Despite occurring more frequently than in the baseline scenario, the LSFE and AWFE (560 Ml/d daily equivalent) are not reliably modelled as achieved on a yearly basis with the desired seasonality as part of the assessment scenario. As such, annual managed Autumn Large Spate releases are recommended as mitigation.
- There is not expected to be a change in water quality in St. John's Beck as a result of the licence renewal.

84 Noting that this assessment has considered daily average flows and not instantaneous flows (as required by the current Section 20 agreement).

As set out in **Section 2.1.2**, the regularity requirement for a Small Flood Flow that is set out in the current Section 20 (July 2021) agreement is as set out in the summary table of the UKTAG guidance on the flow building blocks to a river flow regime with Good Ecological Potential which states that the frequency of a flood flow should be "*once every 3 years*" [85]. This frequency is referred to in King *et al* (2008)[86] which scientifically underpins UKTAG guidance, however, this reference also refers to "*Overturning*" flows, understood as the function of the Small Flood Flow, required on "*perhaps once every one to five years*". With a Small Flood Flow as set out by the UKTAG guidance recommendations not achieved on a one in every three year basis in the modelled natural series, it may be that the current frequency requirement for the Small Flood Flow in the Section 20 agreement should not be such a specific target for St. John's Beck.

The supporting hydrological assessment then cumulates with a suite of recommended feasible mitigation releases to support the ecological functioning of St. John's Beck. There are recapped in **Table 4-1**.

**Table 4-1 Recommendations for annual releases from Thirlmere to support the ecological functioning of St. John's Beck (all magnitude values are inclusive of the compensation flow requirement). The compensation flow arrangements as included in the abstraction licence are not reviewed separately.**

| Release name | Magnitude | Total allocation | Timing | Frequency and duration | Additional comments |
|---|---|---|---|---|---|
| **Autumn and Winter Flow Elevations** | 2x 560 Ml/d (6.48 $m^3/s$) | 400 Ml | September to mid-November | 2 x releases to total 6 hours at maximum release rate<br>Release will be increased to, and reduced from, the maximum release rate at a rate of change not exceeding 2.89 $m^3/s$ per hour (250 Ml/d per hour) | The feasibility of the 6.48 $m^3/s$ magnitude release is uncertain and varies based on reservoir head. As such, the maximum achievable rate based on reservoir head should be released. |
| | 5x 103.94 Ml/d (1.2 $m^3/s$) | 903 Ml | Throughout October to December, inclusive. | 5 x releases, indicated as 48 hours duration. As directed by EA Fisheries Officer | As part of the Section 20 waterbank (2015) allocation. |
| | Open Mill Gill Aqueduct Large Penstock to Howe Beck to provide up to 50 Ml/d (0.57 $m^3/s$) | Up to 2,800 Ml | Between the 3rd week of October and the end of December | For an eight week period | As stipulated in the Section 20 waterbank (2015). |

85 *cf.* Appendix 6: Background to suggested good ecological potential flow criteria in UKTAG (2013) River flow for good ecological potential Final recommendations
86 King et al (2008), Environmental Flow Assessments for Rivers: Manual for the Building Block Methodology (Updated Edition), August 2008, Page 171.

| | | | | | |
|---|---|---|---|---|---|
| **Spring flow elevations** | 84 Ml/d (0.97 $m^3/s$) | 70 Ml | Late April / May to June inclusive. | Once annually. Indicated as 24 hours duration. As directed by EA Fisheries Officer | As already permitted through the Section 20 waterbank (2015) – though not specified in the waterbank guide. |

Following the hydrological assessment, the HRA has been undertaken. Through the HRA Stage 1 screening only one European designated site has the potential to be impacted by the licence renewal and has been included in HRA Screening, this is the River Derwent and Bassenthwaite SAC.

Informed through the hydrological assessment, potential impacts on the qualifying features of the River Derwent and Bassenthwiate Lake SAC relevant to St. John's Beck have been assessed. The assessment of the aquatic ecology features in St. John's Beck has been informed by the findings from the 2016 IIAA[3] to support the Environmental Impact Assessment for the West Cumbria Transfer Scheme. The 2016 IIAA identified those features that were at risk of being impacted through a change in the flow regime in St. John's Beck as a result of the TTS and reservoir level based FDD in combination being operational in comparison with the reference scenario. The assessment presented in this report has considered each of these features and identified the potential impact on these features as a result of the licence renewal.

The assessment has generally identified positive impacts on the qualifying features associated with the licence renewal, including ceasing the current reservoir level based FDD agreement, with greater magnitude and frequency of high flows improving the geomorphological functioning of St. John's Beck. It was identified that the potential increase in flows as a result of the licence renewal and ceasing reservoir level based FDD releases could lead to displacement of juvenile lamprey and Atlantic salmon and result in increased flooding affecting otter rest sites, however it was concluded that, as the predicted spill rates would be closer to the reference scenario and do not introduce more high flow events than the reference scenario, it is not considered that the licence renewal would result in further adverse effects than the reference scenario to these features. Notwithstanding, the licence renewal would not restore the high flow regime to exactly that of the reference scenario, there remains the need for flow release mitigation measures to ensure sufficient diversity and regularity of high flow events in St. John's Beck (see **Table 4-1**).

# A1 Modelling Report

The hydrological assessment of the effects of Thirlmere and the Mill Gill Aqueduct on St John's Beck and Howe Beck has been supported by hydrological modelling. UU's water resources model has been used. This Report provides a summary of UU's water resources model and its applicability for use in this assessment.

Topics covered in this report are:

- Model description
- Model parameterisation
- Model calibration and validation
- Model outputs
- Model suitability statement.

## Model description

The UU Aquator™ water resources model was selected to assess the impacts of different water management scenarios on water resources and to generate data for analysis of reservoir spill magnitude, duration and frequency. Thirlmere is a critical component of UU's Strategic Resource Zone, which supplies much of the North West of England. Its operation is closely linked to the performance of the wider Strategic Resource Zone, and Aquator™'s ability to represent this dynamic relationship makes it the most appropriate tool for this assessment.

UU's Aquator™ model has been developed and refined over approximately 15 years and is widely used for regulatory submissions, including Water Resource Management Plans (WRMPs) and Drought Plans. During this time, the model has undergone multiple validation exercises and independent audits, ensuring its robustness and credibility.

In addition to hydrology, the model integrates essential operational and system data, including customer demand, asset capacities (such as Thirlmere's storage), abstraction licence constraints, and operational rules. These inputs are regularly reviewed and updated, ensuring that all Aquator™ modelling reflects the most current information available at the time of assessment.

## Model parameterisation

For this environmental report, the model uses the 19,200-year daily stochastic flow dataset generated by Atkins for industry-wide application. The stochastic dataset was produced by Atkins using a weather generator as part of a national project to develop hydrological inputs for all water companies in England and Wales for the 2024 Water Resource Management Plans (WRMPs) and Regional Plans. These

datasets are also intended for use in the 2029 planning cycle, ensuring consistency across regulatory submissions.

The weather generator produced synthetic rainfall and potential evapotranspiration (PET), which were then converted into flow series using UU's Catchmod rainfall–runoff models. This process ensures that catchment characteristics and soil moisture dynamics are appropriately represented in the inflow data used by the Aquator model.

Because the dataset was primarily designed for drought planning, validation and bias correction focused on low rainfall periods to improve reliability during dry conditions. While this approach reduces confidence in extreme high-flow events, the dataset remains suitable for assessing flood-related scenarios due to its breadth and consistency. The use of stochastic hydrology for flood studies is well established in academic and industry practice.

The key advantage of this approach is that it allows us to use a single, consistent dataset to assess high-flow events and water resources impacts. Although uncertainties inherent in hydrological modelling remain the benefits of using a standardised, industry-approved dataset outweigh the limitations of developing a bespoke flood-focussed dataset within the available timeframe.

## Model calibration and validation

UU's Aquator™ model has been developed and refined over approximately 15 years and is widely used for regulatory submissions, including Water Resource Management Plans (WRMPs) and Drought Plans. During this time, the model has undergone multiple validation exercises and independent audits, ensuring its robustness and credibility.

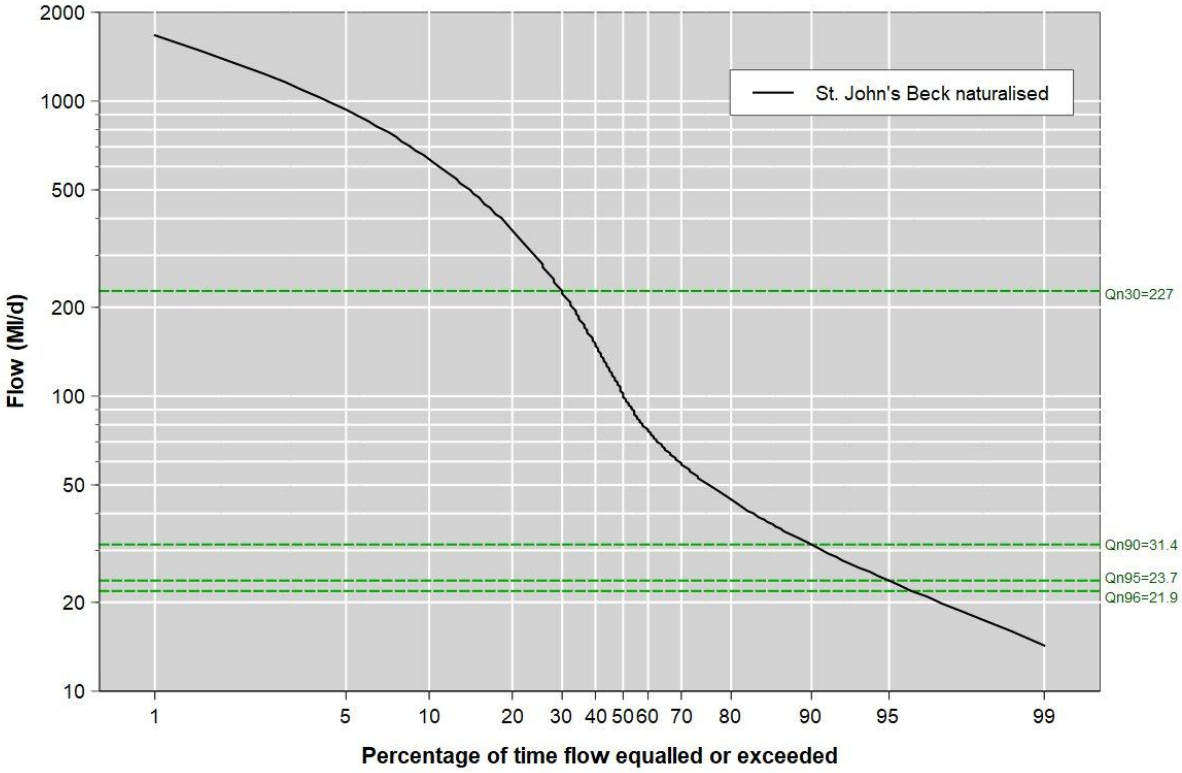
## Model outputs

**Naturalised scenario**

The model inflow series to Thirlmere is used as surrogate for naturalised flow. The inflow series is developed from rainfall-runoff modelling as validated above, and is available for and used for the full 19,200 stochastic years. The assessment point is effectively St John's Beck at the Mill Gill confluence (NY317206) as this is the catchment modelled as contributing flow to the reservoir, either directly or via catchwater. It is recognised that the flow attenuation effects of the former lakes in the valley where Thirlmere Dam was constructed (namely Leathes Water and Wythburn Water) are not incorporated into the representation of naturalised flow.

A flow duration curve of this model representation of the naturalised series is included as **Figure A1** below. This includes those flow duration statistics included within the UKTAG (2013) building block scaling approach.

**Figure A1 Flow duration curve of naturalised flow for St. John's Beck (at Mill Gill confluence) with key flow statistics indicated**




**Selection of the 47 year period to illustrate the Environmental Report**

The water resources model has provided 4,800 years of stochastic flow series, 100 x 48 year continuous periods (strings), for selected points throughout the study area. The stochastic flow series represent contemporary climate conditions and provides information on the return frequency, or regularity, of the likely river flow conditions in the catchment.

Within the stochastic series, one of the 48-year strings out of the 400 generated has been selected as having representative flow characteristics to illustrate the environmental report. The selected 48-year string[87] includes a suitable range of regular low and moderate low flow periods. In keeping with the 48-year duration of the string, the selected string does not include extreme low flows that are considered to be less regular than once every fifty years.

To select the representative string, the naturalised flow series (reservoir inflow) was processed and analysed. The daily data for the entire 19,200 years of stochastic inflow data was processed to a water resources year, from 1st April to 31st March. This consisted of removing the initial months of January to March for the first model year and the final months of April to December for the final model year in each of the 400 strings. This provides 47 water resources years for each of the 400 strings.

[87] Note these are 48 calendar years. The environmental assessment period has been selected as a water resources year (1 April to 31 March) and as such the selected period includes 47 water resources years from the 48 calendar years,

From the processed dataset, flow bands (which were initially created by the Centre for Ecology and Hydrology (CEH)[88]) were established for each individual date within a year for all the model flows combined. These bands were created using the same algorithm utilised by CEH. **Table A1** outlines the seven flow band classifications.

**Table A1 CEH Flow Banding Categories and weighting applied to low flows**

| Band | Classification | Low flow weighting value |
|---|---|---|
| **Exceptionally High** | Flows are likely to be in this band 5% of the time | 1 |
| **Notably High** | Flows are likely to be in this band 8% of the time | 2 |
| **Above Normal** | Flows are likely to be in this band 15% of the time | 3 |
| **Normal** | Flows are likely to be in this band 44% of the time | 4 |
| **Below Normal** | Flows are likely to be in this band 15% of the time | 5 |
| **Notably Low** | Flows are likely to be in this band 8% of the time | 6 |
| **Exceptionally Low** | Flows are likely to be in this band 5% of the time | 7 |

A weighted value for each band category (**Table A1**) was used to put emphasis on low flow periods for the environmental report. This provides a score for each day within each water resources year which when added together provided a score of how dry or wet for each year. This was undertaken for each water resources year in each string.

The water resources years were subsequently ranked in order of this score, with drier years (with a higher weighted value) having a higher rank. This was converted into a return period for each modelled year by using the below formula:

Return period = (n + 1)/m
where n = total number of years
and m = rank of modelled year

Ten representative strings for the required return periods were reviewed by graphically assessing the annual return periods for each calendar day, alongside the median line for the ten representative strings.

The selected 47 year sub-set has been used for illustrative purposes only. Assessment in the Environmental Report has been undertaken using the full stochastic series.

**Selection of the 5 year period for daily time step illustrate in the Environmental Report**

Within the illustrative 47 year sub-set, a 5 year period has been used to illustrate daily time-step hydrology. The 5-year period has been selected from the illustrative 47-year series to include flow characteristics that showcase the differences in the scenarios identified in the model output of the 18,800 stochastic years. The 5-year period has been selected by expert judgement.

The selected 5-year period has been used for illustrative purposes only. Assessment in the Environmental Report has been undertaken using the full stochastic series.

[88] see https://eip.ceh.ac.uk/hydrology/water-resources/

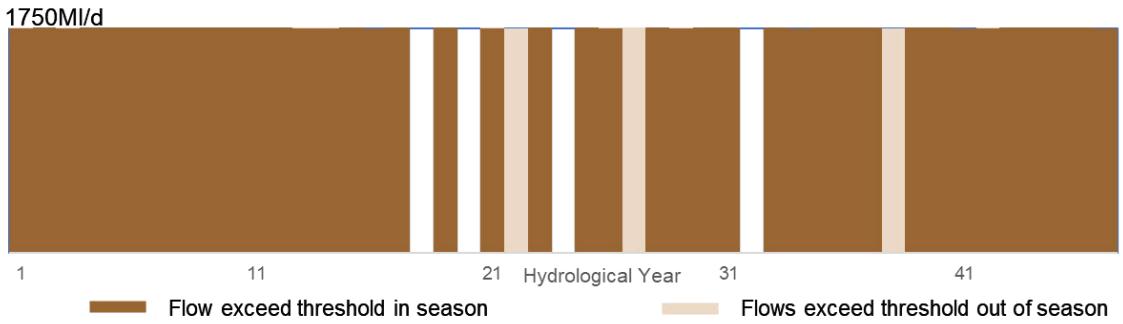
## 4.1 Model suitability statement

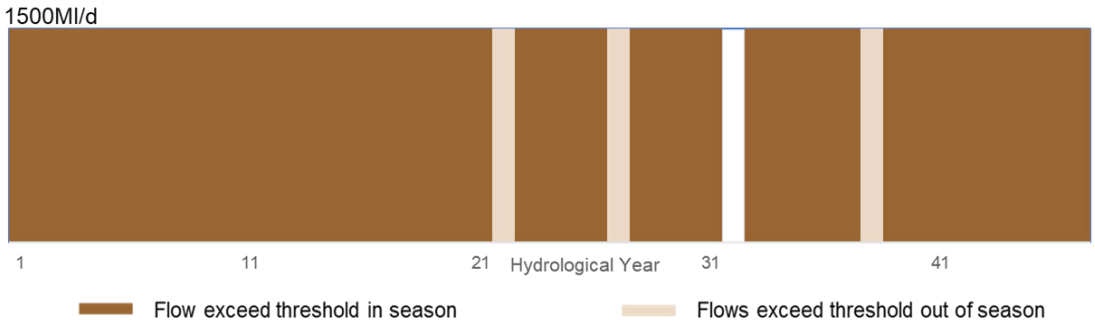
A key strength of Aquator™ is its ability to incorporate extensive hydrological data, enabling simulation of a wide range of scenarios. For this environmental report, the model uses the 19,200-year daily stochastic flow dataset generated by Atkins for industry-wide application. Although this dataset was originally designed for drought planning and calibrated primarily for dry weather conditions, the use of stochastic data in flood-related studies is supported by established academic and industry practice. While confidence in extreme high-flow events is lower than for drought scenarios, the dataset remains suitable for exploring reservoir spill during high flow periods at a daily time step (as used in UKTAG Building Blocks) and only to a 20% return flood frequency (for setting and assessing the largest and rarest UKTAG Building Block tested).

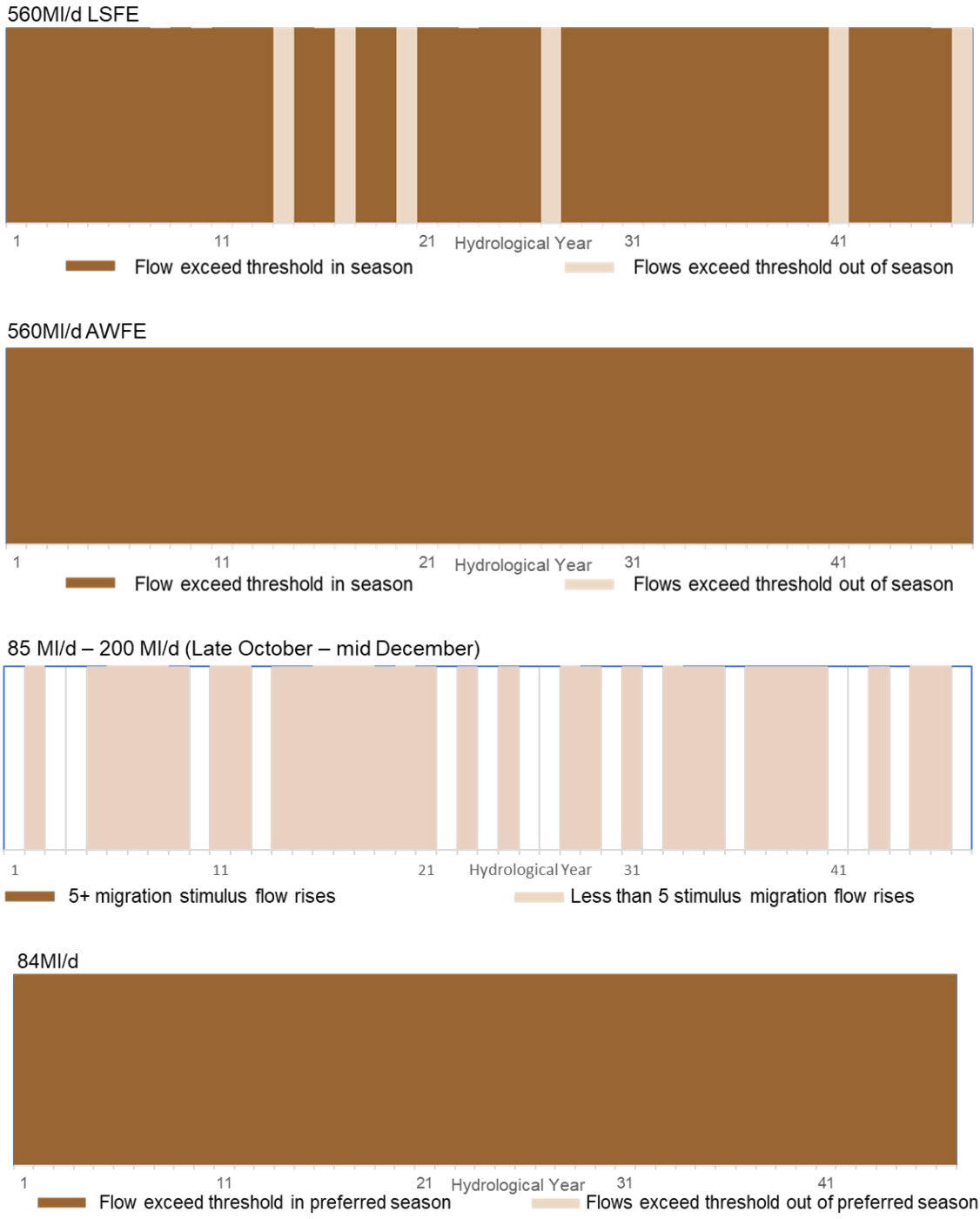
# A2 Modelled naturalised flow scenario assessment

This appendix presents a set of figures applying the flow threshold analysis of the representative 47 year series to the naturalised flow regime. The figures below show the naturalised flow regime compared to the following thresholds:

- Small Flood Flow 2 - 1,750 Ml/d (20.25 $m^3/s$) with preferred seasons being late September to February inclusive
- Small Flood Flow 1 - 1,500 Ml/d (17.36 $m^3/s$) with preferred seasons being late September to February inclusive
- Late Summer Flow Elevations (LSFE) - 560 Ml/d (6.48 $m^3/s$) with preferred seasons being August to September inclusive
- Large Autumn and Winter Flow Elevations (AWFE) - 560 Ml/d (6.48 $m^3/s$) with preferred seasons being October to December inclusive
- AWFE migration stimulus - Five occasions of flow elevation to between 85-200 Ml/d (0.98 $m^3/s$-2.31 $m^3/s$) with preferred seasons being late October to mid-December
- Spring Flow Elevation - 84 Ml/d (0.97 $m^3/s$) with preferred seasons being April to May inclusive (wider seasons include March to June inclusive).






The features of the managed flow regime recommended in **Section 2.3** match their representation within the naturalised 47 year record presented in the figures above with both the Large AWFE (560 Ml/d) and Spring Flow Elevation (84 Ml/d) occurring annually. The fisheries waterbank currently stipulated in the Section 20 (2015) assumed as five releases is a higher frequency within the waterbank period (late October to mid-December) than occurs naturally. The LSFE does not occur on an annual basis, supporting the omission of this as a recommended managed release.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