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HAFREN DYFRDWY
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Hafren Dyfrdwy Drought Plan 2025–30

Environmental Assessment Report for the Augmentation of the River Dee from the Lower Pen-y-Cae Reservoir

Executive Summary

Hafren Dyfrdwy has a statutory duty to prepare and publish a Drought Plan every five years under Sections 39B and 39C of the Water Industry Action Act 1991, as amended by the Water Act 2003, and in accordance with the Drought Plan Regulations 2005 and the Drought Plan Direction (Wales) 2017.

Hafren Dyfrdwy's Drought Plan 2025-2030 details measures that will be taken to maintain supplies to customers under drought scenarios and includes five demand-side measures and one supply-side measure.

This Environmental Assessment Report has been prepared to provide details of the environmental assessment carried out on the supply-side action for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir to ensure that there is an adequate supply of water in the Wrexham Water Resource Zone during drought conditions. This supply-side option will not require a formal drought permit but an environmental assessment has been prepared to support the Drought Plan.

The environmental assessment of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir has been undertaken in accordance with the Water Company Drought Plan – Technical Guidance version 2.0 dated July 2024 published by Natural Resources Wales to demonstrate how it will meet the requirements of relevant legislative requirements for its inclusion within the Drought Plan

Following a '*source-pathway-receptor*' approach, this environmental assessment examines how the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir will affect hydrology, hydromorphology and water quality (pathways) and then considers how ecological and other receptors will respond to changes in those pathways.

The predicted magnitude of impact on each pathway is summarised below.

Water body	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
Potential Impacts on Hydrology				
GB31134451: Pencaye Botton Reservoir	Low	Low	Minor	Medium
GB111067052050 Eitha	Medium	Low	Minor^{+VE}	Medium
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Medium
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Medium
Potential Impacts on Hydromorphology				
GB31134451: Pencaye Botton Reservoir	Low	Low	Negligible	Medium
GB111067052050 Eitha	Medium	Low	Negligible	Medium
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Medium
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Medium
Potential Impacts on Water Quality and WFD Status				
GB31134451: Pencaye Botton Reservoir	Low	Negligible	Negligible	Medium
GB111067052050 Eitha	Medium	Low	Minor	Low
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Low
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Low

The environmental assessment has identified no moderate or major adverse impacts from the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir on ecological and other receptors, with the potential exception of a moderate positive impact on Bullhead, Sea Lamprey and other rheophilic fish species in the River Eitha through the maintenance of flows from the release of water during drought conditions.

As no moderate or major impacts are predicted there is not a requirement for any mitigation or compensation measures to be implemented to prevent or minimise any impact.

This Environmental Assessment Report (EAR) also includes an Environmental Monitoring Plan (EMP) that outlines the proposed monitoring of water quality in the Lower Pen-y-Cae Reservoir, Trefechan Brook and River Eitha.

Contents

1.0 Introduction

1.1 Background

Hafren Dyfrdwy has a statutory duty to prepare and publish a Drought Plan every five years under Sections 39B and 39C of the Water Industry Action Act 1991, as amended by the Water Act 2003, and in accordance with the Drought Plan Regulations 2005 and the Drought Plan Direction (Wales) 2017.

Hafren Dyfrdwy's Drought Plan 2025-2030 (herein referred to as the Drought Plan) details measures that will be taken to maintain supplies to customers under drought scenarios, including an Emergency Drought Order as defined in the Water Resources Act 1991 (as amended).

The Drought Plan contains a number of management actions, the implementation of which are determined by a series of drought triggers. The management actions include: five demand-side measures (e.g. water use restrictions) and one supply-side measure (e.g. increase the availability of water).

As part of its Drought Plan, Hafren Dyfrdwy is required to undertake an environmental assessment of each supply-side option. The environmental assessment supports the Strategic Environmental Assessment (SEA), Habitat Regulations Assessment (HRA) and Water Framework Directive (WFD) Compliance Assessment that have also been carried out and which are presented in stand-alone reports.

This report provides an environmental assessment of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir to negate a reduction in the public water supply (PWS) abstraction from the River Dee during drought conditions. The environmental assessment allows Hafren Dyfrdwy to be '*drought ready*' should any application for a Drought Permit or Drought Order be necessary, although for this supply-side action no such permit or order will be required.

1.2 Purpose of the Environmental Assessment Report

This Environmental Assessment Report (EAR) has been prepared to provide details of the environmental assessment carried out on the supply-side action for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir detailed in the Drought Plan to ensure that there is an adequate supply of water in the Wrexham Water Resource Zone (WRZ) during drought conditions.

This supply-side option will not require a formal drought permit, as it does not require any abstraction or impoundment outside the schedule of any existing licence to increase the amount of water abstracted to supplement supplies, but an environmental assessment has been prepared to support the Drought Plan.

The environmental assessment is not a statutory Environmental Impact Assessment (EIA) but focuses on the implications for hydrology, hydrogeology, water quality, ecology and other relevant water-related environmental issues, i.e. social and cultural features, which may be affected by changes in hydrological regime of any supply-side action for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir.

This Environmental Assessment Report (EAR) also includes an Environmental Monitoring Plan (EMP).

2.0 Augmentation of the River Dee from the Lower Pen-y-Cae Reservoir

2.1 Location and Setting

The River Dee is one of the largest lowland rivers used for public water supplies in England and Wales providing drinking water to over 2.5 million people in north-east Wales, Cheshire and Merseyside. Hafren Dyfrdwy is heavily dependent on the River Dee which supplies 61% of its total raw water and represents 87% of the amount of water supplied to the Wrexham Water Resource Zone (WRZ). The Saltney WRZ is supplied by a bulk import from Severn Trent Water's Chester WRZ, which is also dependent on the River Dee as an important source of water.

Lower Pen-y-Cae Reservoir is on the western side of the villages of Pen-y-Cae, Rhosllannerchurgog and Ruabon, and Pen-y-Cae is approximately 7.8km south-west of Wrexham city centre and 11.4 km west of Bangor-on-Dee where Hafren Dyfrdwy abstracts water from the River Dee for its public water supplies for the Wrexham WRZ (please refer to Figure 1).

2.2 Regulation of the River Dee

The River Dee / Afon Dyfrdwy is regulated under Section 9 of the Dee and Clwyd River Authority Act 1973, the '*Dee General Directions*'[1], and the '*Drought General Directions*' which are managed jointly by Natural Resources Wales (NRW) and the Environment Agency. The Directions are subject to approval by the Dee Consultative Committee (DCC), that comprises NRW, Environment Agency, Hafren Dyfrdwy, Severn Trent Water, United Utilities, Dŵr Cymru Welsh Water, and the Canal and River Trust.

The flows in the River Dee are highly regulated through the release of water from Llyn Tegid (Bala Lake), Llyn Celyn and Llyn Brenig Reservoirs owned and operated by Dŵr Cymru Welsh Water, but managed by NRW. The '*Directions*' ensure that a residual daily mean flow of 4.2m^3/s (363 Ml/d) is maintained over the Chester Weir, under the Normal General Directions, through the controlled release of water to the River Dee via the Bala sluices and sets out the volumes of water that water companies can abstract from the River Dee.

In the event of a drought, the '*Drought General Directions*' define the principles and conditions of the prescribed flows and abstractions in the Dee catchment, and therefore any reductions to abstraction. When the combined Llyn Celyn and Llyn Brenig storage falls below the System Conservation Rule Curve in May – November (inclusive), the principle of maintaining a prescribed flow may be temporarily suspended and substituted by low flow regulation procedures in the '*Directions*'. A special release allocation can also provide additional releases for the benefit of fisheries, water quality or to maintain flows during droughts.

2.3 Augmentation of the River Dee from the Lower Pen-y-Cae Supply-side Action

Supply-side actions are those that increase the availability of water within the system. The Drought Plan has only one supply-side action for the augmentation of the River Dee with water from Lower Pen-y-Cae Reservoir (Figure 1). It should be noted that the supply-side option for the augmentation of the River Dee does not require the abstraction or impoundment outside the schedule of any existing licence to increase the amount of water abstracted to supplement supplies, and therefore does not require a drought permit and no allowance has been made in the Drought Plan for any such application.

[1] NRW / EA (2020). *Dee General Directions*. Issued December 2020.

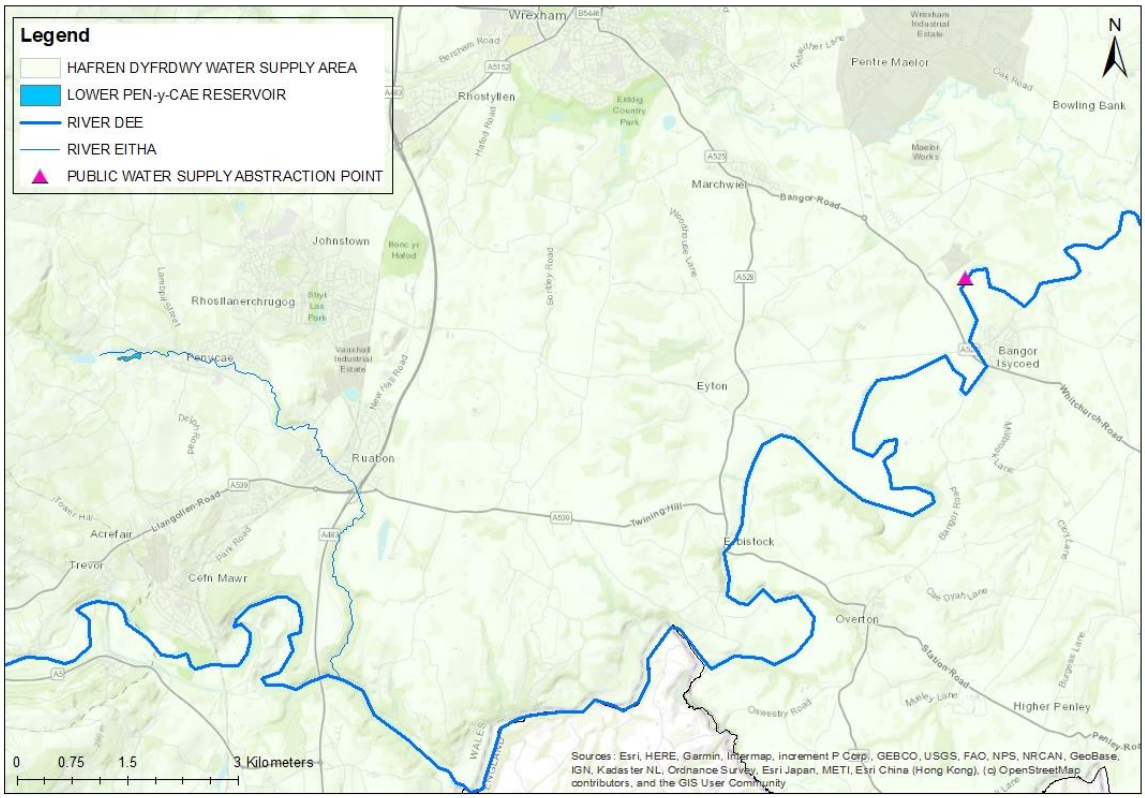

Figure 1: Location of Supply-side Option for the Augmentation of the River Dee

During normal conditions Hafren Dyfrdwy's abstraction from the River Dee at Bangor-on-Dee is constrained by licence conditions and assumes the maximum abstraction does not exceed the '*safe yield allocation*' as established by the Dee General Directions regulating the River Dee.

Under the Dee General Directions, as the status of the Dee Storage System moves from '*developing drought*' to '*drought*' Hafren Dyfrdwy is required to further reduce its abstraction from the River Dee below '*safe yield allocations'* by specified volumes depending on the storage in the Dee Storage System, as detailed in Table 1. How these reductions are made is dependent upon Hafren Dyfrdwy and can be either through reducing abstraction, or by augmenting the River Dee with water from a different source, in this case water from the Lower Pen-y-Cae Reservoir.

Table 1: Dee General Directions and Drought

Abstractor	Maximum Daily Authorised Quantity (Ml/d)	Safe Yield Allocation Net (Ml/d)	Stage 1 Maximum Allocation Net (Ml/d)	Stage 2 Maximum Allocation Net (Ml/d)	Stage 3 Drought General Directions (Ml/d)
Hafren Dyfrdwy at Bangor-on-Dee	45.5	41.5	41.3	41.1	Dee Consultative Committee (DCC) agreed reduction
Severn Trent Water at Boughton (Barrelwell Hill)	36	28.8	28.6	28.4	DCC agreed reduction

As the Dee Storage System enters drought, the River Dee would be augmented with 0.4 Ml/d of stored raw water from the Lower Pen-y-Cae Reservoir, negating the requirement for a 0.2 Ml/d net reduction in abstraction at Bangor-on-Dee and 0.2 Ml/d net reduction in abstraction by Severn Trent Water at Chester. As the Dee Storage System moves from '*drought*' to '*severe drought*', the augmentation would increase from 0.4 to 0.8 Ml/d accounting for a further required reduction in abstraction of 0.2 Ml/d at Bangor-on-Dee and at Chester respectively. Figure 2 summarises the triggers and actions of the River Dee Drought General Directions.

Status	Trigger	Operational Action
Normal	Dee Storage System in Zone 1	Abstraction is only constrained by licence conditions / Lift restrictions if entering zone as part of drought recovery.
	Trigger 1 – Dee Storage System crossing the System Safe Yield Line	Maximum abstraction must not exceed Safe Yield Allocation.
Developing Drought	Trigger 2 - Dee Storage System crossing the System Conservation Rule Curve	Dee Consultative Committee must convene within 7 days to discuss the implementation of Stage 1 Drought General Directions.
Drought	Trigger 3 - Dee Storage System crossing Stage 1 Implementation Curve	Net reduction in abstraction of 0.4Ml/d through the augmentation of the River Dee with water from Pen-y-Cae Reservoir. Dee Consultative Committee convenes within 7 days to discuss the implementation of Stage 2 Drought General Directions. Increased leakage management activities.
Severe Drought	Trigger 4 - Dee Storage System crossing Stage 2 Implementation Curve	Net reduction in abstraction of 0.8Ml/d through the augmentation of the River Dee with water from Pen-y-Cae Reservoir. Dee Consultative Committee convenes to discuss the implementation of Stage 3 Drought General Directions. Plan to implement Temporary Use Bans.
	Trigger 5 - Dee Storage System crossing Stage 3 Implementation Curve	Introduce and enforce Temporary Use Bans. Apply for Drought Orders. Implement Drought Orders

Figure 2: Trigger and Action Diagram for the Dee Drought General Directions

As drought conditions develop, decisions made by the DCC at different stages of the drought will be used to inform early planning of the temporary pump installation process as managed by Hafren Dyfrdwy's Drought

Action Team (DAT). The preparation time to install the temporary pumping station and implement the flow augmentation is anticipated to be within a period of seven days from the day of notification.

When activated, water would be pumped from the Lower Pen-y-Cae Reservoir to the Trefechan Brook / River Eitha by the installation of a temporary pumping station, that would abstract water from the top level of the reservoir and convey water via a pipe placed over the spillway.

The duration of any augmentation of the River Dee will be dependent upon the storage in the Dee Storage System and the volume of water stored at the Lower Pen-y-Cae Reservoir when a drought event (Trigger 3) occurs. Based on the reservoir being full at the start of any augmentation and assuming no flow into the reservoir, the Lower Pen-y-Cae has the capacity to augment flows in the River Dee for up to an estimated 176 days based on an augmentation rate of 0.2 Ml/d reducing to 88 days based on a rate of 0.4 Ml/d in drought conditions (Trigger 3).

In severe drought (Trigger 4) conditions where the augmentation is increased 30 days or 14 days after crossing Trigger 3, releases could be sustained for 59 or 51 days respectively. The scenario period of 30 days is based on the approximate time that it took in 1995 for the Dee System to move from stage 1 to stage 2; the 14 days scenario is more conservative and is approximately the time that it would take to move between the stages based on the most rapid drawdown in 1995.

Table 2 presents a summary of the estimated number of days that Lower Pen-y-Cae Reservoir could potentially augment the River Dee.

Table 2: Estimation of the Potential Duration of Augmentation of the River Dee from Lower Pen-y-Cae Reservoir

Scenario	Estimated Augmentation Days	
	Hafren Dyfrdwy or Severn Trent	Hafren Dyfrdwy and Severn Trent
Drought (Trigger 3)	176 days (0.2 Ml/d)	88 days (0,4 Ml/d)
Drought (Trigger 3) then Severe Drought (Trigger 4) 30 days after crossing Trigger 3	103 days (0.2 then 0.4 Ml/d)	59 days (0.4 then 0.8 Ml/d)
Drought (Trigger 3) then Severe Drought (Trigger 4) 14 days after crossing Trigger 3	95 days (0.2 then 0.4 Ml/d)	51 days (0.4 then 0.8 Ml/d)

2.4 Key Changes Since Last Environmental Assessment

No stand-alone environmental assessment and preparation of an EAR of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir was previously prepared for the Drought Plan 2020-25, but it was reported as part of a wider environmental assessment presented as part of the SEA process.

There have been no significant changes to any of the demand-side and supply-side actions presented in Drought Plan 2020-25 and Drought Plan 2025-30.

2.5 Previous Drought Permits / Drought Orders

There have been a number of periods where North Wales has suffered drought conditions, most recently 1976/77, 1984 and 1995/96. However, to date Hafren Dyfrdwy has not been required to apply for any Drought Permit or Drought Order, ordinary or emergency, and based on historical data there is no instance when a Drought Order would have been required.

2.6 Timing of Drought Measures

It is anticipated that drought conditions would likely occur in late summer / early autumn and the implementation of the supply-side option would likely cover the autumn / winter period. This is because the Dee Storage System typically draws down in late spring / summer and occasionally in early autumn before it refills over the autumn and winter periods. Therefore, the most likely period for the implementation of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir would be between the months of August and December.

3.0 Assessment Methodology

The environmental assessment of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir has been undertaken in accordance with guidance published by NRW[2] and UKWIR[3].

The environmental assessment follows a high-level approach (Figure 3) that assesses the implications of the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir on the environment and demonstrates how it will meet the requirements of relevant legislative requirements for its inclusion within the Drought Plan.

[2] National Resources Wales (2024). Water Company Drought Plan – Technical Guidance version 2.0 dated July 2024. Natural Resources Management Business Group, Sustainable Land and Water Technical Group and Water Policy and Planning Group.
[3] UKWIR (2021). Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans. Report Ref. No. 21/WR/02/15. UK Water Industry Research, London.

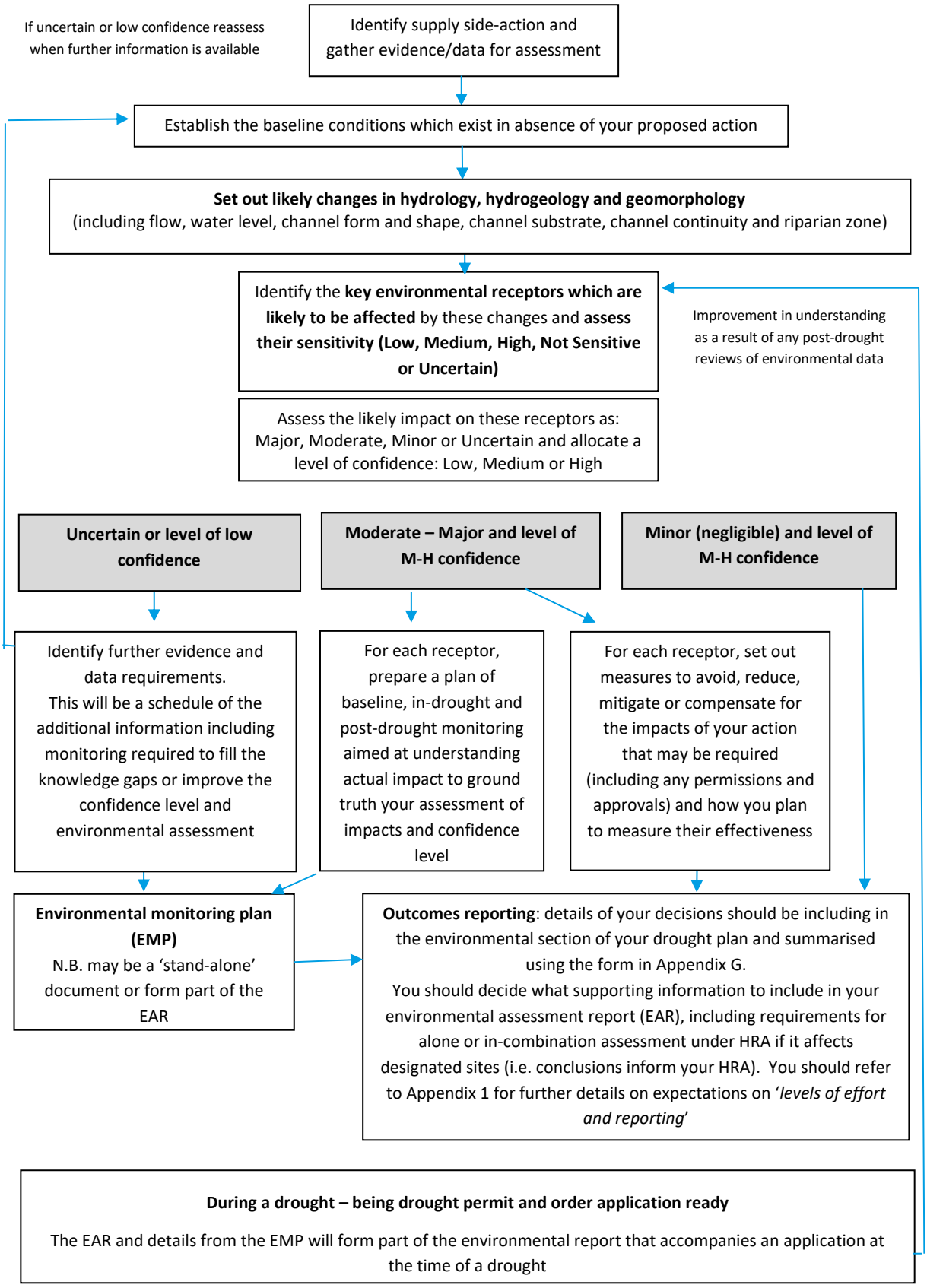

Figure 3: **High-level Approach to Environmental Assessment (NRW Guidelines)**

3.1 Area of Study

The area of study was defined on a spatial scale at which environmental features could be affected through any changes in hydrological conditions by the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir during drought conditions.

Based on the proposed augmentation of the River Dee from the Lower Pen-y-Cae Reservoir it is considered that the potential zone of influence over which environmental features may be affected by physical changes would be confined to the water bodies providing and receiving any augmentation and their associated catchments. These include:

- GB31134451: Pencaye Bottom Reservoir;
- GB111067052050 Eitha;
- GB111067052060 Dee – Ceiriog to Alwen; and
- GB111067057080 Dee Chester Weir to Ceiriog.

The likely extent of any potentially affected water body includes: 7.5 km of the River Eitha (GB111067052050: Eitha) from the Lower Pen-y-Cae Reservoir (GB31134451: Pencaye Botton Reservoir) to its confluence with the River Dee (GB111067052060: Dee – Ceiriog to Alwen) and circa 22km of the River Dee from the confluence of the River Eitha to the abstraction point located north of Bangor-on-Dee (GB111067057080: Dee Chester Weir to Ceiriog). Given that the supply-side action is for the augmentation of water to the River Dee and not reducing flows and lowering water levels through abstraction / impoundment, it is considered that there is not a requirement to assess the implications upstream of these locations. Figure 4 shows the study area and primary area of focus.

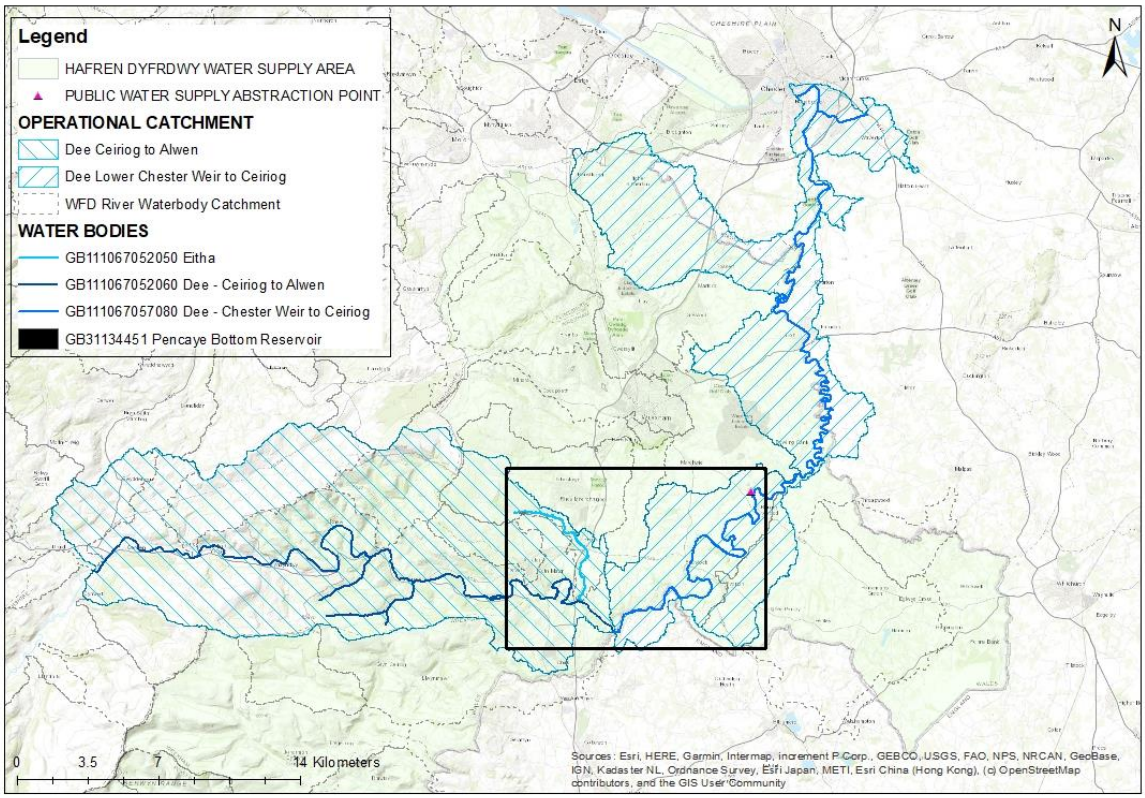

Figure 4: Area of Study and Primary Area of Focus

3.2 Establishing Baseline Conditions

Baseline environmental data was collated through desk-based studies on information publicly available from a number of sources, and building upon information previously collated and presented in support of Hafren Dyfrdwy's Drought Plan 2020-25.

3.3 Environmental Assessment

To assess the likely changes from the proposed supply-side action for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir on the hydrology / hydromorphology of relevant water bodies within the spatial scope of the assessment and on the associated physical environment (hydrology, geomorphology and water quality), ecological features and other environmental features, a source-pathway-receptor approach has been taken.

The assessment of potential environmental impacts can be summarised as:

- the identification of sensitive receptors for assessment;
- identification of the range of potential impacts that may arise from the supply-side action; and
- the consideration of the systems and processes in place to avoid, reduce and mitigate the possible effects of these impacts.

For the purpose of this assessment, the period from May to December inclusive has been assumed for drought conditions based on the principle of maintaining a prescribed flow that may be temporarily suspended and substituted by low flow regulation under the Drought General Directions and which covers the main period when augmentation of the River Dee from the Lower Pen-y-Cae Reservoir is likely to occur (August to December).

3.3.1 Assessing Environmental Sensitivity

The sensitivity of a receptor is a function of its capacity to accommodate change and its ability to recover following any change. Sensitivity can be quantified as:

- Adaptability: the degree to which a receptor can avoid or adapt to an impact;
- Tolerance: the ability of a receptor to accommodate '*temporary*' or '*permanent*' change without a significant adverse impact;
- Recoverability: the temporal scale over and extent to which a receptor will recover following an impact; and
- Value: a measure of the receptors importance, rarity and worth.

Key features of the environment likely to be affected by hydrological changes caused by the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir have been categorised based on their sensitivity to any such changes. Table 3 details the sensitivity categories used in the assessment.

Table 3: Sensitivity Categories

Category	Definition
High	Receptor is highly sensitive to changing environments due to inability to tolerate and recover from changes.
Medium	Receptor is sensitive to changing environments due to limited ability to tolerate and/or recover slowly from the environmental change.
Low	Receptor is relatively insensitive to changing environments due to ability to tolerate and/or recover quickly from the environmental change.
Not Sensitive	Receptor is not sensitive due to high tolerance to environmental change and/or ability to recover rapidly.
Uncertain	Insufficient information is available to judge the sensitivity of the receptor.

3.3.2 Assessment of Likely Impacts

The assessment of likely impacts on identified sensitive receptors has been based on the magnitude of impact defined via four factors, that include: extent over which an impact may occur; duration when an impact occurs; frequency the impact may occur; and severity of change relative to baseline. The magnitude is then categorised as detailed in Table 4.

Table 4: Magnitude Categories

Category	Definition
High	A large, extensive, long-term and/or frequent change.
Medium	A medium-sized, substantial, medium-term and/or frequent change.
Low	A small, localised, short-term and/or infrequent change.
Negligible	A change unlikely to be noticeable / measurable.
Uncertain	Insufficient information is available to judge the magnitude of impact.

The significance of an impact is then determined by a combination of the magnitude of the impact and the sensitivity of an environmental receptor using the matrix as detailed in Table 5.

Table 5: Determining Significance of Impact on Receptors

Magnitude	Sensitivity				
	High	Medium	Low	Not Sensitive	Uncertain
High	Major	Major	Moderate	Minor / Negligible	Uncertain
Medium	Major	Moderate	Minor / Negligible	Minor / Negligible	Uncertain
Low	Moderate	Minor / Negligible	Minor / Negligible	Minor / Negligible	Uncertain
Negligible	Minor / Negligible	Minor / Negligible	Minor / Negligible	Minor / Negligible	Uncertain
Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain

An overall impact on receptors is categorised as: Major, Moderate, Minor / Negligible, or Uncertain based on the significance criteria detailed in Table 6.

Table 6: Significance Categories

Category	Definition
Major	An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment or the nature of an individual receptor.
Moderate	An effect that alters the character of the environment or individual receptor in a manner that is consistent with existing or emerging baseline.
Minor / Negligible	An effect which causes noticeable changes in the character of the environment or individual receptor without affecting its sensitivities or without significant consequences.
Uncertain	Insufficient information is available to judge the significance of an effect on the environment or an individual receptor.

Where a moderate or major impact has been identified during the environmental assessment process this has been defined as significant if unavoidable appropriate mitigation measures are provided to minimise the potential impact.

The final part of the assessment is to assign a level of confidence in the environmental assessment based on the quality of the datasets, evidence and analysis methods used to inform the assessment (Table 7). The level of confidence shows where data gaps may exist and informs where future monitoring may be required.

Table 7: Confidence Categories

Category	Definition
High	Assessment based on high-quality and scientifically robust data, and/or the nature of the impact makes it possible to assess with a high degree of certainty.
Medium	Assessment based on best available data, but not of sufficient quality or scientifically robust to warrant a higher level of confidence.
Low	The information available is too fragmented or poorly corroborated to make solid analytic inferences, or significant concerns or problems with information sources exist.

3.4 Limitations and Uncertainty of Data

Details on the data quality used in the assessment, limitations and assumptions made are included within the impact assessment for any relevant environmental feature.

4.0 Environmental Assessment

4.1 Potential Pathways

The supply-side action for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir will not require the abstraction / impoundment of water from any river or stream, but is rather putting water into the riverine system to offset an equivalent abstraction from the river at two points downstream of the augmentation at Bangor-on-Dee and Chester by Hafren Dyfrdwy and Severn Trent Water respectively for public water supply.

Potential pathways from the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir have been identified as:

- hydrology (river flow regime);
- hydromorphology (river habitats and geomorphology); and
- water quality

Hydrogeology has been screened out from any further assessment as there are no groundwater abstractions associated with the supply-side option for the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir.

4.2 Physical Environment

There are two reservoirs at Pen-y-Cae, namely Upper Pen-y-Cae Reservoir (2.83 ha) and Lower Pen-y-Cae Reservoir (2.02 ha). The reservoirs are fed by the Trefechan Brook that rises high on the Ruabon Moors. The Lower Pen-y-Cae Reservoir is no longer used for public water supply abstraction and does not have any associated compensation release to the Trefechan Brook under its abstraction licence (Licence No. 24/67/5/0003)[4].

The Trefechan Brook rises high on the Ruabon Moors, flowing through a steep valley and the two reservoirs at Pen-y-Cae before it is joined by the Nant y Crogfyn Stream at the village of Pen-y-Cae and forms the River Eitha (GB111067052050 Eitha). The River Eitha flows for 7.5 km in a southerly direction through Ruabon before joining the River Dee east of the A483 and north of Chirk. A diversion channel allows flows in the Trefechan Brook to bypass the Upper and/or Lower Pen-y-Cae Reservoirs where necessary. A spillway at the Lower Pen-y-Cae dam allows water to be conveyed to the Trefechan Brook when this reservoir is full.

The River Dee is the largest river in North Wales with a management catchment area of 2,251 km^2. It flows for approximately 113 km generally in an easterly direction from its source in Snowdonia National Park, via Llyn Tegid and through the Vale of Llangollen before turning northwards through the Cheshire Plain at Bangor-on-Dee to its tidal limit just below Chester and the mudflats of the Dee Estuary. The river has been highly regulated for water storage and supply since the early 19th Century in order to maintain flow during dry periods and reduce peak flows during wetter periods. As a result, the ability of the river to self-regulate has been dramatically reduced.

The two relevant WFD management and reporting river water bodies of the River Dee for this environmental assessment include: Dee – Ceiriog to Alwen (GB11106705206) and Dee Chester Weir to Ceiriog (GB111067057080).

[4] Licence No. 24/67/5/003 covers abstraction from both the Upper and Lower Pen-y-Cae Reservoirs.

4.2.1 Hydrology

4.2.1.1 Baseline River Flow Regime

No long-term flow monitoring is undertaken on the Trefechan Brook or River Eitha.

Spot-flow gauging was undertaken on the Trefechan Brook and River Eitha in September 2020 during low flow conditions as part of an investigation to quantify the volume of water that needed to be released to ensure that augmentation flows of up to 0.8 Ml/d reached the River Dee. This investigation recorded mean flows of 0.42 Ml/d (Trefechan Brook upstream of Nant y Crogryn), 1.47 Ml/d (River Eitha downstream of Nant y Crogfryn) and 2.34 Ml/d (River Eitha at Rhiw Goch). During drought conditions these low flows are likely to be further reduced.

Long-term monitoring of flows is undertaken at several locations on the River Dee; however, the Manley Hall gauging station has been deemed relevant to this environmental assessment.

The River Dee at the Manley Hall gauging station has a mean flow rate of 341 m^3/s and a Q_{95} flow of 6.57 m^3/s (568 Ml/d)[5]. The regulation of the River Dee should maintain adequate flows, as far as is practicably possible, but under drought conditions flows are likely to be lower than under normal conditions.

4.2.1.2 Assessment of Effects on River Flow Regime

The Lower Pen-y-Cae Reservoir is fed directly via the Trefechan Brook or from the spillway of the Upper Pen-y-Cae Reservoir. During drought conditions the Trefechan Brook is likely to be dry with no water being fed into the Upper and Lower Pen-y-Cae Reservoirs. No water would also be released from the Upper Pen-y-Cae Reservoir to the Lower Pen-y-Cae Reservoir to conserve the water supply for customers. As a result, the use of any stored water in the Lower Pen-y-Cae Reservoir to augment the River Dee would accelerate the rate of drawdown in this waterbody if the supply-side option was to be implemented. However, any abstraction for the augmentation of the River Dee would be within the existing licence limits and would not extend beyond the operating volume of the reservoir accounting for dead storage volume of 10%. Based on the storage capacity of the reservoir, water could be released from Lower Pen-y-Cae Reservoir to the Trefechan Brook for up to a maximum of 176 days. The rate of drawdown would however be dependent upon the rate of augmentation required.

The release of 0.4 to 0.8 Ml/d from the Lower Pen-y-Cae Reservoir to the Trefechan Brook will enhance flows and water levels in the Trefechan Brook and River Eitha during drought (Trigger 3) to severe drought (Trigger 4) conditions when these are likely to be experiencing no and low flows respectively, and provide a degree of resilience against drought conditions for these watercourses and associated aquatic habitats and biota. The water released is likely to have a positive temporary impact on the hydrological regime of both of these water bodies, but especially on the River Eitha with little loss of any augmented water anticipated in this water body, based on accretion recorded during the spot-flow gauging carried out in 2020.

The duration of any impact from the release of water into the Trefechan Brook and River Eitha will be dependent upon a number of factors but is likely to be between 51 and 176 days depending on the rate of augmentation, the time for the Dee System to move between Stage 1 and Stage 2 and if releases are for Hafren Dyfrdwy and/or Severn Trent Water.

The release of up to 0.8 Ml/d in the Trefechan Brook and River Eitha would equate to <0.2% of the Q_{95} flow in the River Dee, as measured at Manley Hall (568 Ml/d) downstream of the confluence with the River Eitha. This would be within the <5% deviation at Q_{N95} in accordance with Common Standards Monitoring (CSM) guidance for Rivers[6] and for Freshwater Fauna[7], and within the flow regime of 10% of recent actual flow as detailed in the

[5] NRFA Station Data for 67015 - Dee at Manley Hall (ceh.ac.uk)
[6] JNCC (2014). *Common Standards Monitoring Guidance for Rivers*. Version September 2016. JNCC, Freshwater, ISSN 1743-8160.
[7] JNCC (2015). *Common Standards Monitoring Guidance for Freshwater Fauna*. Version October 2015. JNCC, Freshwater, ISSN 1743-8160.

Core Management Plan for the River Dee and Bala Lake/Afon Dyfrdwy a Llyn Tegid SAC[8]. Based on these figures, the augmentation is not likely to result in any adverse changes to the hydrological regime of the River Dee at the confluence of the River Eitha and downstream of this point.

A summary of potential impacts on the river flow regime of the relevant water bodies is provided in Table 8.

Table 8: Summary of Potential Impacts on River Flow Regime

Water body	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
GB31134451: Pencaye Botton Reservoir	Low	Low	Minor	Medium
GB111067052050 Eitha	Medium	Low	Minor^{+VE}	Medium
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Medium
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Medium

4.2.2 Hydromorphology

4.2.2.1 Baseline Hydromorphology

The Lower Pen-y-Cae Reservoir (GB31134451: Pencaye Botton Reservoir) has an impoundment depth of up to 6.6m and is designated a Drinking Water Protected Area (Surface Water) defined by the Water Environment (Water Framework Directive) (England & Wales) Regulations 2017 but is no longer used for public water supply abstraction.

The River Eitha (GB111067052050) is classified as a heavily modified waterbody. Where it flows through the villages of Pen-y-Cae and Ruabon, it is a shallow moderate flowing watercourse with a mean channel width of 1.5 to 2m largely constrained by vertical engineered artificial banks and with some evidence of its historical use in the past to power watermills. The substrate typically comprises of cobbles interspersed with gravels and sand but with some areas of finer silts deposited in slower flowing pools and bends. Past Ruabon, the gradient increases as it flows through a wooded vale becoming more natural in appearance before joining the River Dee.

Dee – Ceiriog to Alwen (GB11106705206) extends from the confluence of the River Alwen in Denbighshire to the confluence with the River Ceiriog near Wrexham through the Vale of Llangollen. However, only a section of circa 2.4km flows below the confluence of the River Eitha with the majority of this water body and catchment upstream of this location. This section of the River Dee generally is a steep gradient river with confined meandering due to narrow and steep valley comprising a series of glides and runs, but with some cascades at Llangollen.

Dee Chester Weir to Ceiriog (GB111067057080) extends from the confluence of the Ceiriog to its tidal limit at Chester (Chester Weir) and in parts forms the boundary with England. At Erbistock Weir the nature of the river changes from a relatively steep gradient to a more moderate gradient as it flows through the plains of Cheshire. The river comprises predominantly of deep slow flowing sections with some shallower fast flowing sections within an unconfined channel with an extensive alluvial floodplain.

4.2.1.3 Assessment of Effects on Hydromorphology

The release of water from the Lower Pen-y-Cae Reservoir during drought conditions will not result in any reduced water levels, flow velocities or in the wetted perimeter of the Trefechan Brook or River Eitha or where

[8] NRW (2008). *Core Management Plan including Conservation Objectives for River Dee and Bala Lake/Afon Dyfrdwy a Llyn Tegid SAC*. Version 3 dated September 2022. Natural Resources Wales.

there would be any implications for reducing flows at any artificial in-channel barriers, i.e. weirs, water level control structures in these watercourses. During the period of any augmentation, the release of water from the Lower Pen-y-Cae Reservoir will provide a degree of resilience to the riverine habitats against a drought event by maintaining the basic function of the River Eitha.

The use of a temporary pumping station has the potential to abstract water from the reservoir, and discharge into the Trefechan Brook has the potential to mobilise silts from the bed of the Lower Pen-y-Cae Reservoir which may accumulate if the bed of the Trefechan Brook is dry. However, through the use of a floating pump and abstraction to the operational level of the reservoir, any significant silt mobilisation to the Trefechan Brook is considered unlikely.

Any mobilisation of silts from the bed of the Trefechan Brook as a result of the discharge of water is not likely to be at levels where this would significantly alter sediment transportation, deposition where this would result in changes to channel form (width and depth) and/or in substrate composition in either the Trefechan Brook and/or River Eitha, and where there would be effects on the riverine habitats.

The augmentation of up to 0.8 Ml/d representing <0.2% of the Q_{95} flow in the River Dee will have no measurable effects on the hydromorphology and habitats of Dee – Ceiriog to Alwen (GB11106705206) and Dee Chester Weir to Ceiriog (GB111067057080) water bodies of the River Dee. The augmentation will ensure that the basic function of this river is not significantly altered through the continued abstraction of water for public water supplies by Hafren Dyfrdwy and/or Severn Trent Water.

A summary of potential impacts on the hydromorphology of the relevant water bodies is provided in Table 9.

Table 9: Summary of Potential Impacts on Hydromorphology

Water body	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
GB31134451: Pencaye Botton Reservoir	Low	Low	Negligible	Medium
GB111067052050 Eitha	Medium	Low	Negligible	Medium
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Medium
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Medium

4.2.3 Water Quality and Water Framework Directive Status

4.2.3.1 Baseline Water Quality

Water quality sampling at the surface, middle and bottom of the water column from one site at the deepest part of Lower Pen-y-Cae Reservoir, was undertaken monthly from June to October 2020. This sampling recorded diluted concentrations of aluminium, iron, lead, manganese and zinc increasing with depth and exceeding any associated Environmental Quality Standards (EQS) for these elements for some of the samples taken. The increasing levels of heavy metals was likely due to restricted mixing induced by stratification and the release of these elements from anoxic bottom sediments in the reservoir. Since this time the Lower Pen-y-Cae Reservoir has been fully drained to allow for maintenance works. More recent water samples were taken from eight location from the Lower Pen-y-Cae Reservoir, Trefechan Brook, Nant y Corgryn and the River Eitha on 28th August 2024 as proposed in the Environmental Monitoring Plan. Figure 5 shows the location of the sampling sites and the results of the water analysis carried out by ALS Laboratories (UK) Limited is presented in Table 10.

The results of the water quality analysis would indicate that the water in the Lower Pen-y-Cae Reservoir does not exceed any EQS for freshwater.

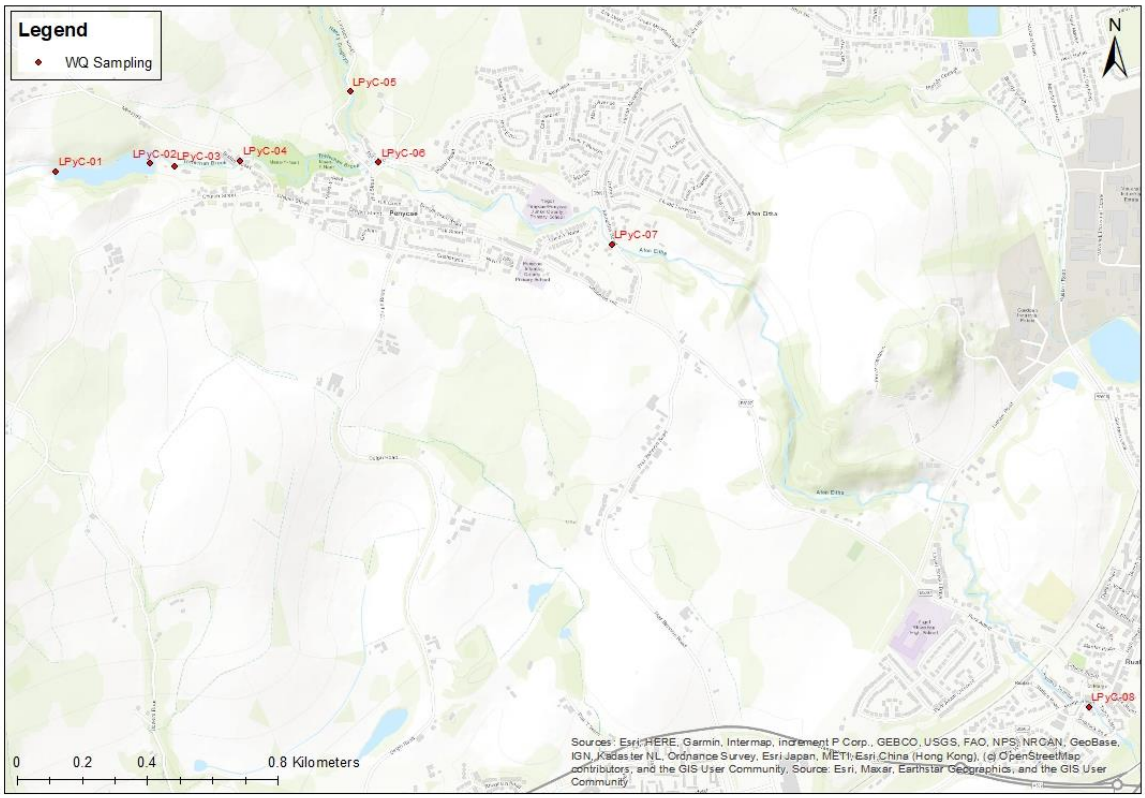

Figure 5: Location of Water Quality Sampling

Table 10: Water Quality Analysis (August 2024)

Parameter	Units	Sampling Site								Standards	
		LPyC-01 Lower Pen-y-Cae Reservoir	LPyC-02 Lower Pen-y-Cae Reservoir	LPyC-03 Trefechan Brook	LPyC-04 Trefechan Brook	LPyC-05 Nant y Crogryn	LPyC-06 River Eitha	LPyC-07 River Eitha	LPyC-08 River Eitha	Annual Average EQS Freshwater	UK Drinking Water
pH	pH units	7.7	7.6	8.0	7.8	8.0	8.0	8.0	8.0		
BOD	mg/l	<1	<1	<1	<1	<1	<1	<1	<1	1.51	
Conductivity	uS/cm	219	218	210	222	261	258	268	316		
Ammoniacal Nitrogen as N	mg/l	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41		
Nitrite as N	mg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08		50 mg/l
Nitrogen, Total Oxidised as N	mg/l	<0.7	<0.7	<0.7	<0.7	1.2	<0.7	<0.7	<0.7		
Nitrogen, Total as N	mg/l	<0.5	1.0	0.9	0.9	1.4	0.7	1.3	0.8		
Phosphate, Ortho as P	mg/l	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6		
Sulphate as SO_4	mg/l	<4.4	<4.4	8.3	9.9	<4.4	7.9	11.1	27.2	400 mg/l	250 mg/l
Phenols Mono	mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	7.7 µg/l	0.5 µg/l
Ammonium as NH_4	mg/l	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	0.2 – 0.25 mg/l[4]	0.5 mg/l
Aluminium	mg/l	0.0177	0.0188	0.0385	0.0464	0.0932	0.0495	0.0587	0.0463	-	200 µg/l
Phosphorus	mg/l	0.018	0.022	<0.013	0.032	0.036	0.033	0.023	0.021	10 – 50 µg/l[2]	2200 µg/l
Iron	mg/l	0.266	0.281	0.224	0.197	0.366	0.201	0.188	0.182	1 mg/l	0.2 mg/l
Manganese	mg/l µg/l Bio	0.199 112.8	0.206 95.29	0.0346	0.0226	0.0141	0.0127	0.0094	0.0263	123 µg/l[3]	50 µg/l
Nickel	mg/l µg/l Bio	<0.0010 0.22	<0.0010 0.20	0.0040	<0.0010	<0.0010	<0.0010	<0.0010	0.0017	4 µg/l[3]	20 µg/l
Copper	mg/l µg/l Bio	<0.0018 0.04	<0.0018 0.04	<0.0018	<0.0018	0.0129	<0.0018	<0.0018	0.0019	1 µg/l[3]	2000 µg/l
Zinc	mg/l µg/l Bio	<0.006 1.48	<0.006 1.52	0.006	<0.006	<0.006	<0.006	0.009	0.077	10.9 µg/l[3]	5000 µg/l
Arsenic	mg/l	0.00071	0.00075	0.00047	0.00048	0.00090	0.00049	0.00053	0.00042	50 µg/l	10 µg/l
Cadmium	mg/l	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007	<0.00007	0.00010	0.00081	0.08 – 0.25 µg/l	5 µg/l
Lead	mg/l	<0.0003	<0.0003	0.0004	0.0006	0.0014	0.0009	0.0020	0.0022	1.2 µg/l[3]	10 µg/l
Chromium – Hexavalent	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	3.4 µg/l	50 µg/l
Mercury	µg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07µg/l[2]	1 µg/l

Notes:

1. Standards as set out in JNCC's Common Standards Monitoring for Rivers.
2. Maximum allowable concentration.
3. Bioavailable values. Bioavailability values have been calculated for the Lower Pen-y-Cae Reservoir from the water samples taken and using the UK TAG M-BAT tool kit.
4. Standards for the River Dee. However, the reporting level for water sampling analysis undertaken for Ammonium at 0.53 mg/l is above the 0.2 – 0.25 mg/l standard as defined for the River Dee.
5. All figures in red indicate where any standard has been exceeded.

The River Dee is routinely sampled for its water quality by NRW; however, no regular sampling routine is currently carried out on the River Eitha.

Table 11 presents a summary of the current Water Framework Directive (WFD) status (Cycle 3) for all relevant water bodies carried forward for assessment into the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir.

Table 11: WFD Status (RBMP Cycle 3) and Confidence Rating[9]

Parameter	GB31134451: Pencaye Botton Reservoir	GB111067052050: Eitha	GB111067052060: Dee – Ceirog to Alwen	GB111067057080: Dee Chester Weir to Ceiriog
Waterbody Type	Lake	River	River	River
Designation	Heavily Modified	Heavily Modified	Heavily Modified	Heavily Modified
Overall Waterbody Status	**Good**	**Good**	**Good**	**Moderate**
Overall Ecological Status	**Good**	**Good**	**Good**	**Moderate**
Biological Quality	Not assessed	Good	Good	Good
Fish	-	Good (uncertain)	-	-
Invertebrates	-	High (quite certain)	High (very certain)	High (quite certain)
Macrophytes and Phytobenthos Combined	-	-	Good (quite certain)	Good (quite certain)
Macrophyte Sub-element	-	-	High (very certain)	Good (quite certain)
Phytobenthos Sub-element	-	-	Good (quite certain)	Good (uncertain)
Physio-Chemical Quality	Not assessed	High	Good	Good
Ammonia (NH_3)	-	High (quite certain)	High (very certain)	High (very certain)
Biochemical Oxygen Demand (BOD)	-	-	High (very certain)	High (very certain)
Dissolved Oxygen	-	High (quite certain)	High (very certain)	High (very certain)
pH	-	High (very certain)	High (very certain)	High (very certain)
Phosphate (P)	-	High (very certain)	High (very certain)	Good (very certain)
Temperature	-	High (uncertain)	High (uncertain)	Good (uncertain)
Hydromorphological Supporting Elements	No assessed	Not assessed	Not assessed	Not assessed
Specific Pollutants	Not assessed	High	High	High
2,4-dichlorophenol	-	High (very certain)	High (very certain)	High (very certain)
2,4-dichlorphenoxyacetic acid (2,4-D)	-	High (very certain)	High (very certain)	High (very certain)
Arsenic	-	-	High (very certain)	High (very certain)
Chlorothalonil	-	High (very certain)	High (very certain)	High (very certain)
Copper	-	-	High (very certain)	High (very certain)
Chromium VI	-	-	-	High (very certain)
Diazinon	-	-	High (very certain)	High (quite certain)
Dimethoate	-	High (very certain)	High (very certain)	High (very certain)
Glyphosate	-	High (very certain)	High (very certain)	High (very certain)
Iron	-	-	High (very certain)	High (very certain)
Linuron	-	High (very certain)	High (very certain)	High (very certain)
Manganese	-	-	High (very certain)	High (very certain)
Mecoprop	-	High (very certain)	High (very certain)	High (very certain)
Phenol	-	-	High (very certain)	High (very certain)

[9] https://datamap.gov.wales/

Parameter	GB31134451: Pencaye Botton Reservoir	GB111067052050: Eitha	GB111067052060: Dee – Ceirog to Alwen	GB111067057080: Dee Chester Weir to Ceiriog
Toluene	-	-	-	High (very certain)
Triclosan	-	-	High (very certain)	High (very certain)
Zinc	-	-	High (very certain)	High (very certain)
Chemical	**Not assessed**	**High**	**High**	**Moderate**
Priority Hazardous Substances	-	High	High	Moderate
Antracene	-	-	High (very certain)	High (very certain)
Cadmium	-	-	High (very certain)	High (very certain)
Endosulfan	-	-	High (very certain)	High (very certain)
Hexachlorocyclohexane (HCH)	-	High (very certain)	High (very certain)	High (very certain)
Nonylphenol (NP) (4-nonlyphenol)	-	-	High (very certain)	High (very certain)
Pentachlorobenzene	-	High (very certain)	High (very certain)	High (very certain)
Polyaromatic hydrocarbons (PAH)	-	-	-	Moderate
Tributyl tin compounds (TBT) (tributyltin-cation)	-	-	High (very certain)	High (very certain)
Trifluralin	-	High (very certain)	High (very certain)	High (very certain)
Priority Substances	Not assessed	High	High	High
1,2-dichlorphenol	-	-	High (very certain)	High (very certain)
Aclonifen	-	High (very certain)	High (very certain)	High (very certain)
Alachlor	-	High (very certain)	High (very certain)	High (very certain)
Atrazine	-	-	High (very certain)	High (very certain)
Benzene	-	-	High (very certain)	High (very certain)
Bifenox	-	High (very certain)	High (very certain)	High (very certain)
Clorvinfos	-	High (very certain)	High (very certain)	High (very certain)
Chlorphyrifos (chlorphyrifos-ethyl)	-	High (very certain)	High (very certain)	High (very certain)
Dichloromethane	-	-	High (very certain)	High (very certain)
Dichlorvos	-	-	High (very certain)	High (very certain)
Diuron	-	High (very certain)	High (very certain)	High (very certain)
Fluoranthene	-	-	-	High (very certain)
Isoprotron	-	High (very certain)	High (very certain)	High (very certain)
Lead	-	-	High (very certain)	High (very certain)
Nickel	-	-	High (very certain)	High (very certain)
Octylphenol	-	-	-	High (very certain)
Pentachlorophenol	-	High (very certain)	High (very certain)	High (very certain)
Quinoxyfen	-	High (very certain)	High (very certain)	High (very certain)
Simazine	-	High (very certain)	High (very certain)	High (very certain)
Terbutryn	-	High (very certain)	High (very certain)	High (very certain)
Trichloromethane (chloroform)	-	-	High (very certain)	High (very certain)
Other Pollutants	Not assessed	High	High	High
Carbon-tetrachloride	-	-	-	High (very certain)
Drins	-	High (very certain)	High (very certain)	High (very certain)
Para-para-DDT	-	High (very certain)	High (very certain)	High (very certain)

A summary of regulated discharges encompassing the River Eitha and River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's public water supply abstraction at Bangor-on-Dee is presented in Table 12.

Table 12: Regulated Discharges

Receiving Water Body	Permit Number	Discharge Type	NGR
GB111067052050 Eitha	CM0176401	Sewer network Combined Storm Overflow (CSO) by water undertaker	SJ 28516 45238
GB111067052050 Eitha	CM0176201	Emergency sewer overflow by water undertaker	SJ 28724 45263
GB111067052050 Eitha	CG0358201	Sewer discharge by water undertaker	SJ 30324 43661
GB111067052050 Eitha	CG0358201	Sewer storm overflow by water undertaker	SJ 30324 43661
GB111067052060 Dee – Ceiriog to Alwen	CM0022001	Final effluent discharge from wastewater treatment works by water undertaker	SJ 30383 40592
GB111067057080 Dee Chester Weir to Ceiriog	CG0408201	Sewage and industrial trade effluent	SJ 36181 41183
GB111067057080 Dee Chester Weir to Ceiriog	CM0188601	Sewer storm overflow by water undertaker	SJ 36625 41598
GB111067057080 Dee Chester Weir to Ceiriog	CM0112101	Final effluent discharge from wastewater treatment works by water undertaker	SJ 35575 41955
GB111067057080 Dee Chester Weir to Ceiriog	HB3193HK	Treated sewer discharge non-water undertaker	SJ 35384 42667
GB111067057080 Dee Chester Weir to Ceiriog	CG0368401	Treated sewer discharge non-water undertaker	SJ 35420 42700

4.2.3.2 Assessment of Effects on Water Quality

The release of 0.4 to 0.8 Ml/d from the Lower Pen-y-Cae Reservoir to the Trefechan Brook has the potential to affect water quality and the Water Framework Directive Status of the River Eitha and River Dee where it is of lesser quality than that of the receiving water bodies during the period of any augmentation. However, any water released would be water that under normal conditions could flow through the system from the Lower Pen-y-Cae Reservoir to the Trefechan Brook without any prior treatment.

The augmentation from the Lower Pen-y-Cae Reservoir is not predicted to result in a reduction of water quality or in any deterioration in the overall WFD status of this water body.

The Lower Pen-y-Cae Reservoir has historically had elevated levels of certain heavy metals towards the bottom of the water column at its deepest point, likely as a result of stratification in this water body and potentially anoxic bottom sediments. However, given the size and depth of the Lower Pen-y-Cae Reservoir it would be expected that any stratification is likely to be weak and the water column would be subject to a degree of mixing, especially during the period when any augmentation releases are likely to occur (autumn). Notwithstanding this, as the augmentation releases from the Lower Pen-y-Cae Reservoir would take water from the surface layer, it is anticipated that as water levels fall any weak stratification would easily dissipate, due to the mixing effect of any wind and gradual warming of water, increasing dissolved oxygen levels at depth and reducing anoxic conditions in the bottom sediments as this reservoir is drawn down. This would be expected to reduce the concentrations of metal elements in the water column and in water released to the Trefechan Brook.

Based on the most recent water quality analysis, it is considered that the release of water from the Lower Pen-y-Cae Reservoir is not likely to have any significant long-term effects on chemical water quality in the River Eitha or River Dee.

There is the potential for a difference in the levels of dissolved oxygen (DO_2) and temperature of water in the Lower Pen-y-Cae and River Eitha. However, the differentiation will be dependent upon the flow conditions in the River Eitha during a drought event. The pumping of water from the reservoir to the Trefechan Brook would

be anticipated to increase levels of DO_2 through the agitation of this water as it is released and limiting any potential impact of released water with a higher temperature which may occur to that in the River Eitha. Any decrease in DO_2 and increase in temperature in the River Eitha is likely to be minor and be outweighed by the maintenance of flows during a drought event.

The River Eitha is currently assessed with an overall water body status of '*Good*' with '*Good*' ecological status and '*High*' chemical status. The release of water from the Lower Pen-y-Cae Reservoir for a temporary period of up to six months is not predicted to result in any deterioration in the overall, ecological (fish and invertebrates) and chemical WFD status of this water body.

The River Dee is currently assessed with an overall water body status of '*Good*' with '*Good*' ecological status and '*High*' chemical status at the confluence of the River Eitha. Due to the dilution between the flow rates in the river and the contribution of <0.2% from any augmentation, no adverse effects are predicted on water quality and no deterioration in the overall, ecological (invertebrates, macrophyte and phytobenthos) and chemical WFD status is predicted on either the Dee – Ceiriog to Alwen or Dee Chester Weir to Ceiriog water bodies.

The augmentation of the River Dee will not reduce water levels, therefore there will not be any cumulative impacts on water quality from the effects of reduced dilution of discharged wastewater from any regulated discharges to the River Eitha and River Dee.

A summary of potential impacts from changes in water quality on the relevant water bodies is provided in Table 13.

Table 13: Summary of Potential Impacts on Water Quality and WFD Status

Water body	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
GB31134451: Pencaye Botton Reservoir	Low	Negligible	Negligible	Medium
GB111067052050 Eitha	Medium	Low	Minor	Low
GB111067052060 Dee – Ceiriog to Alwen	High	Negligible	Negligible	Low
GB111067057080 Dee Chester Weir to Ceiriog	High	Negligible	Negligible	Low

4.3 Biodiversity, Flora and Fauna

This section assesses the potential implications on statutory and non-statutory designated sites, habitats and species, as listed under Section 7 of the Environment (Wales) Act 2016 (as amended), other protected and notable species, and invasive non-native species (INNS).

4.3.1 Designated Sites and Habitats of Principal Importance

4.3.1.1 Statutory Designated Sites

Table 14 summarises the statutory designated sites within the operational catchments of each of the relevant water bodies and high-level screening to determine which sites should be carried forward for further assessment.

Table 14: Statutory Designated Sites

Site	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Berwyn a Mynyddoedd De Clwyd / Berwyn and South Clywd Mountains SAC	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No: site is upstream of the Lower Pen-y-Cae Reservoir and therefore no potential source-pathway-receptor linkage.
Berwyn SPA	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No: site is upstream of the confluence of River Eitha with River Dee.
Dee Cliffs, Farndon SSSI (England)	GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No: geological site not dependent upon hydrology.
Afon Dyfrdwy (River Dee) SSSI	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
River Dee (England) SSSI	GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Ruabon / Llantysilio Mountains and Minera SSSI	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No: site is upstream of the Lower Pen-y-Cae reservoir and confluence of River Eitha with River Dee.
Nant-y-Belan and Prynela Woods SSSI	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen	Uncertain	No: although site is located at the confluence of the River Eitha and River Dee with potential hydrological linkages to these waterbodies, the augmentation will not reduce flows in either the River Eitha or River Dee and therefore, there is no potential source-pathway-receptor linkage from the supply-side option.
Castell y Waun a'i Barcdir / Chirk Castle and Parkland SSSI	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No: not hydrologically linked to the River Dee.
Caeau Pen-y-coed SSSI	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No: site is upstream of the confluence of River Eitha with River Dee.
Dina Bran SSSI	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No: site is upstream of the confluence of River Eitha with River Dee.
Berwyn SSSI	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No: site is upstream of the confluence of River Eitha with River Dee.
Cloy Brook Pastures SSSI	GB111067057080 Dee Chester Weir to Ceiriog	Medium	No: hydrologically linked to the River Dee through the Cloy Brook with no source-pathway-receptor linkage from the supply-side option.
Old Pulford Brook Meadows SSSI	GB111067057080 Dee Chester Weir to Ceiriog	Medium	No: hydrologically linked to the River Dee through the Cloy Brook with no source-pathway-receptor linkage from the supply-side option.

4.3.1.2 Non-statutory Designated Sites and Habitats of Principle Importance

There are no non-statutory designated sites, i.e. Local Wildlife Site (LWS), Sites of Local Importance for Nature Conservation (SLINC) etc. which are located on or within 500m of the River Eitha or River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's PWS abstraction at Bangor-on-Dee.

Table 15 identifies the Habitats of Principle Importance[10] within 500m of the River Eitha or River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's public water supply abstraction at Bangor-on-Dee and high-level screening to determine if these habitats should be carried forward for further assessment.

Table 15: Habitats of Principle Importance

Habitat of Principal Importance	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Ancient Woodland	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Uncertain	No: although site is located at the confluence of the River Eitha and River Dee with potential hydrological linkages to these waterbodies, the augmentation will not reduce flows in either the River Eitha or River Dee. Therefore, there is no potential source-pathway-receptor linkage from the supply-side option.
Wood Pasture and Parkland	GB111067052050 Eitha GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No: habitat is not dependent upon the River Eitha and River Dee.
Traditional Orchards	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No: habitat is not dependent upon the River Eitha and River Dee.
Coastal and Floodplain Grazing Marsh	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Medium	No: habitats are hydrologically linked to the River Dee however, the augmentation will not reduce flows in the River Dee and therefore there is no potential source-pathway-receptor linkage from the supply-side option.
Lowland Fens	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Medium	No: habitats are typical groundwater dependent and therefore there is no source-pathway-receptor linkage from the supply-side option.

4.2.2.3 Assessment of Effects on Designated Sites and Habitats of Principal Importance

The assessment of effects on the designated sites carried forward for assessment has looked at the implications from any changes in hydrological regime and water quality from the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir on the potential degradation of habitats and the ability of these habitats to support any associated species. An assessment on any notable associated species is presented under the Flora and Fauna section.

[10] Habitats listed under Section 7 of the Environment (Wales) Act 2016 as habitats of principal importance.

River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC comprises of the component SSSIs which include Afon Dyfrdwy (River Dee) SSSI and River Dee (England) SSSI. River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid qualifies as a SAC for the following habitats listed under Annex I of the EU Habitats Directive:

- 3260 Water courses of plain to montane levels with *the Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

The Afon Dyfrdwy (River Dee) SSSI / River Dee (England) SSSI comprises a range of river habitat-types from mesotrophic to eutrophic and saltmarsh transition habitats.

The augmentation of the River Dee from the Lower Pen-y-Cae Reservoir will not result in any reduction in flows or water levels in the River Dee. The assessment on changes to the hydrological regime and water quality would have a negligible magnitude impact on the River Dee and a negligible impact on any of its associated riverine habitats.

A summary of potential impacts on the designated sites is provided in Table 16.

Table 16: Summary of Potential Impacts on Designated Sites

Environmental Feature	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
Changes in Hydrological Regime				
River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC	High	Negligible	Negligible	Medium
Afon Dyfrdwy (River Dee) SSSI	High	Negligible	Negligible	Medium
River Dee (England) SSSI	High	Negligible	Negligible	Medium
Changes in Water Quality				
River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC	High	Negligible	Negligible	Medium
Afon Dyfrdwy (River Dee) SSSI	High	Negligible	Negligible	Medium
River Dee (England) SSSI	High	Negligible	Negligible	Medium

4.3.2 Flora and Fauna

4.3.2.1 Flora

Table 17 identifies protected, rare and notable (including Invasive Non-Native Species (INNS)) species of aquatic and wetland flora associated with the River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC / River Dee SSSI and which have been recorded within any 1km grid square encompassing the River Eitha and River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's PWS abstraction at Bangor-on-Dee, and high-level screening to determine which species should be carried forward for further assessment.

Table 17: Protected, Rare and Notable Species of Flora

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Features of River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC and River Dee SSSI			
Floating Water-plantain *Luronium natans*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	No, not identified as a key species Annex II for any of these water bodies in the Core Management Plan for the River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC[11] and all likelihood of absence.
Slender Hare's-ear *Bupleurum tennuissimum*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No; species of importance for SSSI associated with disturbed coastal sites and all likelihood of absence.
Water Sedge *Carex aquatilis* and *Carex aquatilis x Carex acuta*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No; species of importance for SSSI associated with Llyn Tegid and all likelihood of absence.
Sea Barley *Hordeum marinum*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No; species of importance for SSSI associated with coastal sites and all likelihood of absence.
Mudwort *Limosella aquatica*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No; species of importance for SSSI associated with Llyn Tegid and all likelihood of absence.
Other Protected, Rare and Notable Species[12]			
Tubular Water-dropwort *Oenanthe fistulosa*	GB111067057080 Dee Chester Weir to Ceiriog	Low	No, a wetland species listed in S7 of the Environment (Wales) Act 2016, but which is not likely to be found in the River Dee and affected by the augmentation of this river.
Invasive Non-native Species			
Canadian Waterweed *Elodea canadensis*	GB111067057080 Dee Chester Weir to Ceiriog	Low	Yes
Japanese Knotweed *Fallopia japonica*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No, the augmentation will not reduce flows in the River Dee and therefore no potential spread of this species to areas available for colonisation from a reduction in wetted channel.
Himalayan Balsam *Impatiens glandulifera*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No, the augmentation will not reduce flows in the River Dee and therefore no potential spread of this species to areas available for colonisation from a reduction in wetted channel.

[11] Natural Resources Wales (2022). Core Management Plan Including Conservation Objectives for River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid (Wales) SAC. Version 3 dated September 2022. Natural Resources Wales.
[12] Based on biological records held by https://aderyn.lercwales.org.uk/ and https://bsbi.org/maps, and in particular taking into account of any aquatic and wetland species listed under Section 7 of the Environment (Wales) Act 2016 as species of principal importance.

4.3.2.2 Fish

Lower Pen-y-Cae Reservoir was drained in 2023 to allow for maintenance works to be carried out. All fish stocks in the reservoir were captured and relocated to the Upper Pen-y-Cae Reservoir, with the exception of European eel that were released in the Trefechan Brook. In 2024, to allow maintenance works on the Upper Pen-y-Cae Reservoir, fish stocks were relocated back to the Lower Pen-y-Cae Reservoir. Table 18 provides a summary of the fish species, and numbers captured and released during the maintenance works at each reservoir.

Table 18: Lower Pen-y-Cae Reservoir Fish Stocks

Relocated From Lower Pen-y-Cae Reservoir 2023		Relocated from Upper Pen-y-Cae Reservoir 2024	
Species	**No**	**Species**	**No**
Perch *Perca fluviatilis*	2000	Perch *Perca fluviatilis*	900
Rudd *Scardinius erythrophthalmus*	1000	Rudd *Scardinius erythrophthalmus*	300
Brown Trout *Salmo trutta*	15	Brown Trout *Salmo trutta*	60
Three-spined Sticklebacks *Gasterosteus aculeatus*	50	Three-spined Sticklebacks *Gasterosteus aculeatus*	Numerous
European eel *Anguilla Anguilla*	20		
Rainbow Trout *Oncorhynchus mykiss*	3		

The River Dee is monitored at a number of locations for the lamprey species but there are also records of other species found during electro-fishing surveys. The River Eitha was also subject to some fish surveys from 2001 to 2014. Table 19 identifies the fish species associated with River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC / River Dee SSSI and within any 1km grid squares encompassing the River Eitha and River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's PWS abstraction at Bangor-on-Dee, and high-level screening to determine which species should be carried forward for further assessment. Please note that the sensitivity at this stage does not take into account any seasonal variation in life history characteristics of individual fish species and is based on the highest sensitivity levels.

Table 19: Fish Species

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Features of River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC and River Dee SSSI			
Atlantic Salmon *Salmo salar*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Sea Lamprey *Petromyzon marinus*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Brook Lamprey *Lampetra planeri*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Medium	Yes
River Lamprey *Lampetra fluviatilis*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Bullhead *Cottus gobio*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Whitefish *Coregonus lavaretus*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No, a species with its population associated with and of importance for SSSI associated with Llyn Tegid, and all likelihood of absence in lower sections of the River Dee.
European Smelt *Osmerus eperianus*	GB111067057080 Dee Chester Weir to Ceiriog	No sensitive	No, species is associated with the sea and intertidal areas and is not likely to be affected by the augmentation of the River Dee.
Other Fish Species[13]			
European eel *Anguilla Anguilla*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Medium	Yes
Limnophilic species (species preferring static or low velocity water) including: Perch *Perca fluviatilis*, Rudd *Scardinius erythrophthalmus* and Three-spined Sticklebacks *Gasterosteus aculeatus*	GB31134451: Pencaye Botton Reservoir	Medium	Yes
Rheophilic Species (species preferring moderate to fast flowing water, coarse gravel and cobble substrate) including: Stone Loach *Barbatula barbatula*, Minnow *Phoxinus phoxinus* and Brown Trout *Salmo trutta*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes

4.3.2.3 Invertebrates

Lower Pen-y-Cae Reservoir (GB31134451: Pencaye Botton Reservoir) is not assessed under the WFD for invertebrates, but GB111067052050 Eitha, GB111067052060 Dee – Ceiriog to Alwen, and GB111067057080 Dee Chester Weir to Ceiriog all have '*High*' WFD status for invertebrates (2022 Cycle 3).

The River Eitha at Ruabon and the River Dee at Erbistock, Overton Bridge and Bangor-0n-Dee have historically been sampled for macroinvertebrates as part of the assessment of WFD ecological status (please refer to Table 8). The most recent sampling results are from 2013[14]. No WHPT scores or NTaxa data has been sourced, but taxonomic groups and species records indicate that these are typical of what would be expected in clean moderate flow water bodies.

The River Dee SSSI is also notable for four species of invertebrates as detailed in Table 20.

[13] Based on biological records held by https://datamap.gov.wales/maps/new?layer=geonode:nrw_freshwater_fish_surveys#/, https://aderyn.lercwales.org.uk/ and https://bsbi.org/maps
[14] https://datamap.gov.wales/maps/new?layer=geonode:nrw_river_macroinvertebrates#/

Table 20: Invertebrate Species

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Invertebrate Features of River Dee SSSI			
Yellow Crucifer Weevil *Aulacobaris lepidii*	GB111067057080 Dee Chester Weir to Ceiriog	Low	Yes
Scarce Yellow Sally Stonefly *Isogenus nubecula*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	High	Yes
Club-tailed Dragonfly *Gomphus vulgatissimus*	GB111067057080 Dee Chester Weir to Ceiriog	Medium	Yes
Glutinous Snail *Myxas glutinosa*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No, a species with its population associated with and of importance for SSSI associated with Llyn Tegid, and all likelihood of absence in lower sections of the River Dee.
Other Freshwater Macroinvertebrates			
Freshwater macroinvertebrate communities	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Medium	Yes

Whilst there are a number of records for non-native freshwater invertebrate species, for example New Zealand Mud Snail Potamopyrgus antipodarum, these are not included as they are not listed under Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) or species of special concern under The Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019.

4.3.2.4 Other Protected Species

Table 21 identifies other protected and notable species of aquatic and wetland flora associated with River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC / River Dee SSSI and which have been recorded within any 1km grid square encompassing the River Eitha and River Dee extending from the Lower Pen-y-Cae Reservoir to Hafren Dyfrdwy's PWS abstraction at Bangor-on-Dee, and high-level screening to determine which species should be carried forward for further assessment.

Table 21: Other Protected and Notable Species

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Features of River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC and River Dee SSSI			
Otter *Lutra lutra*	GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	Yes
Other Protected Species			
Water Vole *Arvicola amphibius*	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	Yes
Breeding waterbirds	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No, the period when the augmentation of the River Dee is likely to be active is outside the main breeding season for birds.
Overwintering / migratory waterbirds	GB31134451: Pencaye Botton Reservoir GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No, any overwintering / migratory birds are likely to move to more favourable areas providing foraging and roosting opportunities not impacted by drought.
Invasive Non-native Species			
American Mink	GB31134451: Pencaye Botton Reservoir GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No, although the species is typically associated with riverine and wetland habitats they are not sensitive to hydrological changes.

4.3.2.3 Assessment of Potential Impacts on Flora and Fauna

The following section provides an assessment of the potential impact on flora and fauna of each relevant river water body.

GB111067052050 Eitha

The release of water from the Lower Pen-y-Cae Reservoir for the augmentation of the River Dee is assessed as likely to have a minor to moderate positive impact on the flora and fauna of the River Eitha, including fish, macroinvertebrates and any protected species, by maintaining flows and a wetted perimeter during drought conditions.

The release of water from the Lower Pen-y-Cae Reservoir for a temporary period of up to three months may result in a reduction in chemical water quality. However, it is assessed that the significance of any impact would be negligible for all flora and fauna with no element likely to be of sufficient concentration where there would be a significant risk of mortality or any long-term measurable toxicological effects on fish and macroinvertebrate fauna.

A summary of potential impacts on the flora and fauna of the River Eitha is provided in Table 22.

Table 22: Summary of Potential Impacts on the Flora and Fauna of the River Eitha

Environmental Feature	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
Changes in Hydrological Regime				
Fish				
Sea Lamprey *Petromyzon marinus*	High	Low^{+ve}	Moderate^{+ve}	Medium
Brook Lamprey *Lampetra planeri*	Medium	Low^{+ve}	Minor^{+ve}	Medium
Bullhead *Cottus gobio*	High	Low^{+ve}	Moderate^{+ve}	Medium
European eel *Anguilla Anguilla*	Medium	Low^{+ve}	Minor^{+ve}	Medium
Rheophilic Species	High	Low^{+ve}	Moderate^{+ve}	Medium
Limnophilic species	Medium	Low	Minor	Medium
Freshwater Macroinvertebrates				
Freshwater macroinvertebrate communities	Medium	Low^{+ve}	Minor^{+ve}	Medium
Other Protected Species				
Water Vole *Arvicola amphibius*	Low	Low^{+ve}	Minor^{+ve}	Medium
Changes in Water Quality				
Fish				
Sea Lamprey *Petromyzon marinus*	High	Negligible	Negligible	Low
Brook Lamprey *Lampetra planeri*	Medium	Negligible	Negligible	Low
Bullhead *Cottus gobio*	High	Negligible	Negligible	Low
European eel *Anguilla Anguilla*	Medium	Negligible	Negligible	Low
Rheophilic Species	High	Negligible	Negligible	Low
Limnophilic species	Medium	Low	Minor	Low
Freshwater Macroinvertebrates				
Freshwater macroinvertebrate communities	Medium	Negligible	Negligible	Low
Other Protected Species				
Water Vole *Arvicola amphibius*	Low	Negligible	Negligible	Low

River Dee (GB111067052060 Dee – Ceiriog to Alwen / GB111067057080 Dee Chester Weir to Ceiriog)

The augmentation of the River Dee from the Lower Pen-y-Cae Reservoir of up to 0.8 Ml/d would equate to <0.2% of the Q_{95} flow in the River Dee downstream of the confluence of the River Eitha and is within the CSM parameters of <5% deviation at Q_{N95} for freshwater fauna[15], and is not likely to result in any adverse changes on the hydrological flow regime of the River Dee. It is not likely that there would be any significant changes in water chemistry due to sufficient dilution of any augmented water, therefore, there is a negligible impact for any flora and fauna supported by this river.

Any change in flow regime is not likely to significantly change baseline conditions where INNS are likely to spread or colonise new areas of the river channel, margins and banks.

A summary of potential impacts on the Dee – Ceiriog to Alwen and Dee Chester Weir to Ceiriog water bodies are provided in Tables 23 and 24 respectively.

[15] JNCC (2015). *Common Standards Monitoring Guidance for Freshwater Fauna*. Version October 2015. JNCC, Freshwater, ISSN 1743-8160.

Table 23: Summary of Potential Impacts on Flora and Fauna of the Dee – Ceiriog to Alwen

Environmental Feature	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
Changes in Hydrological Regime				
***Fish Features of** River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC*				
Atlantic Salmon *Salmo salar*	High	Negligible	Negligible	Medium
Sea Lamprey *Petromyzon marinus*	High	Negligible	Negligible	Medium
Brook Lamprey *Lampetra planeri*	Medium	Negligible	Negligible	Medium
River Lamprey *Lampetra fluviatilis*	High	Negligible	Negligible	Medium
Bullhead *Cottus gobio*	High	Negligible	Negligible	Medium
Other Fish				
European eel *Anguilla Anguilla*	Medium	Negligible	Negligible	Medium
Rheophilic Species	Medium	Negligible	Negligible	Medium
***Invertebrate Features of** River Dee SSSI*				
Scarce Yellow Sally Stonefly *Isogenus nubecula*	High	Negligible	Negligible	Medium
Freshwater Macroinvertebrates				
Freshwater macroinvertebrate communities	Medium	Negligible	Negligible	Medium
***Other Protected Species of the** River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC*				
Otter *Lutra lutra*	Low	Negligible	Negligible	Medium
Other Protected Species				
Water Vole *Arvicola amphibius*	Low	Negligible	Negligible	Medium
Changes in Water Quality				
***Fish Features of** River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC*				
Atlantic Salmon *Salmo salar*	High	Negligible	Negligible	Medium
Sea Lamprey *Petromyzon marinus*	High	Negligible	Negligible	Medium
Brook Lamprey *Lampetra planeri*	Medium	Negligible	Negligible	Medium
River Lamprey *Lampetra fluviatilis*	High	Negligible	Negligible	Medium
Bullhead *Cottus gobio*	High	Negligible	Negligible	Medium
Other Fish				
European eel *Anguilla Anguilla*	Medium	Negligible	Negligible	Medium
Rheophilic Species	Medium	Negligible	Negligible	Medium
***Invertebrate Features of** River Dee SSSI*				
Scarce Yellow Sally Stonefly *Isogenus nubecula*	High	Negligible	Negligible	Medium
Freshwater Macroinvertebrates				
Freshwater macroinvertebrate communities	Medium	Negligible	Negligible	Medium
***Other Protected Species of the** River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC*				
Otter *Lutra lutra*	Low	Negligible	Negligible	Medium
Other Protected Species				
Water Vole *Arvicola amphibius*	Low	Negligible	Negligible	Medium

Table 24: Summary of Potential Impacts on Flora and Fauna of the Dee – Chester Weir to Ceiriog

Environmental Feature	Sensitivity	Magnitude of Impact	Significance of Impact	Confidence Level
Changes in Hydrological Regime				
***Fish Features of** River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC*				
Atlantic Salmon *Salmo salar*	High	Negligible	Negligible	Medium
Sea Lamprey *Petromyzon marinus*	High	Negligible	Negligible	Medium
Brook Lamprey *Lampetra planeri*	Medium	Negligible	Negligible	Medium
River Lamprey *Lampetra fluviatilis*	High	Negligible	Negligible	Medium
Bullhead *Cottus gobio*	High	Negligible	Negligible	Medium
Other Fish				
European eel *Anguilla Anguilla*	Medium	Negligible	Negligible	Medium
Rheophilic Species	Medium	Negligible	Negligible	Medium
***Invertebrate Features of** River Dee SSSI*				
Yellow Crucifer Weevil *Aulacobaris lepidii*	Low	Negligible	Negligible	Medium
Scarce Yellow Sally Stonefly *Isogenus nubecula*	High	Negligible	Negligible	Medium
Club-tailed Dragonfly *Gomphus vulgatissimus*	Medium	Negligible	Negligible	Medium
Freshwater Macroinvertebrates				
Freshwater macroinvertebrate communities	Medium	Negligible	Negligible	Medium
Other Protected Species of the River Dee and Bala Lake / Afon Dyfrdwy a Llyn Tegid SAC				
Otter *Lutra lutra*	Low	Negligible	Negligible	Medium
Other Protected Species				
Water Vole *Arvicola amphibius*	Low	Negligible	Negligible	Medium
Invasive Non-Native Species				
Canadian Waterweed *Elodea canadensis*	Low	Negligible	Negligible	Medium

4.4 Navigation, Recreation and Heritage

This section describes the impacts of the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir on navigation, recreation and recreation during drought conditions.

4.4.1 Navigation

The River Dee is navigable downstream from Farndon Bridge, and Farndon to the Dee Estuary which is along the lower section of GB111067057080 Dee Chester Weir to Ceiriog. As the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir will not lower water levels there will be no source-pathway-receptor for impacts on navigation and is screened out from further assessment.

4.4.2 Recreation

Lower Pen-y-Cae Reservoir is used for recreational fishing by a small local club. The use of stored water for the augmentation of the River Dee will result in the potential temporary closure of this facility as water levels become low in the reservoir.

The River Dee is renowned for its salmon, trout and sea trout fishery as well as for grayling, with a number of private fishing clubs managing sections of river including amongst others: Newbridge Angling Association, Bryn-y-Pys Angling Association, Bangor-on-Dee Salmon Angling Club and Wirral Game Fishing Club.

The environmental assessment has identified a negligible impact on all species of fish in the River Dee with no adverse changes on the hydrological flow regime or water chemistry predicted from the augmentation using water from the Lower Pen-y-Cae Reservoir, therefore this is screened out from further assessment.

4.4.3 Heritage

The local area has a rich cultural heritage that includes one World Heritage Site (WHS), 14 Registered Historic Parks and Gardens (RHPGs), 66 Scheduled Ancient Monuments (SAMs) as well as numerous listed buildings, which lie within the operational catchments of each of the relevant water bodies. Table 25 summarises the heritage features and high-level screening to determine which sites should be carried forward for further assessment.

Table 25: Heritage Features

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
World Heritage Sites			
Pontcysyllte Aqueduct and Canal	GB111067052060 Dee – Ceiriog to Alwen	Medium	No, WHS lies upstream of the proposed augmentation of the River Dee.
Registered Historic Parks and Gardens			
Plas yn iâl	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No
Llantysilio Hall / Plas Llantysilio	GB111067052060 Dee – Ceiriog to Alwen	Low	No, RHPG lies upstream of the proposed augmentation of the River Dee.
Bryntysilio	GB111067052060 Dee – Ceiriog to Alwen	Low	No, RHPG lies upstream of the proposed augmentation of the River Dee.
Vivod	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No
Valle Crucis Abbey / Abaty Glyn y Groes	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No
Trevor Hall / Neuadd Trevor	GB111067052060 Dee – Ceiriog to Alwen	Not sensitive	No
Argoed Hall / Neuadd Argoed	GB111067052060 Dee – Ceiriog to Alwen	Low	No, RHPG lies upstream of the proposed augmentation of the River Dee.
Whitehurst	GB111067052060 Dee – Ceiriog to Alwen	Low	No, RHPG lies upstream of the proposed augmentation of the River Dee.
Chirk Castle / Castell y Waun	GB111067052060 Dee – Ceiriog to Alwen	Low	No, RHPG lies upstream of the proposed augmentation of the River Dee.
Wynnstay	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No
Pen-y-Lan	GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No
Erbistock Hall / Neuadd Erbistock	GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No

Species	Waterbody Catchment	Sensitivity to hydrological changes	Carried Forward for Further Assessment
Eaton Hall	GB111067057080 Dee Chester Weir to Ceiriog	Medium	No, although the RHPG lies adjacent to a long stretch of the River Dee, this site is a considerable distance downstream of the augmentation near Chester and is outside the potential zone of any hydrological impacts.
Grosvenor Park	GB111067057080 Dee Chester Weir to Ceiriog	Not sensitive	No
Scheduled Ancient Monuments			
All Scheduled Ancient Monuments	GB111067052050 Eitha GB111067052060 Dee – Ceiriog to Alwen GB111067057080 Dee Chester Weir to Ceiriog	Low	No, the supply-side action will not lower groundwater levels where there is a higher likelihood of impact on waterlogged deposits required for the preservation of archaeological remains rather than from any hydrological inputs.

4.5 Other Abstractors

The augmentation of the River Dee from the Lower Pen-y-Cae Reservoir has no adverse implications for any other abstractions from this river and no cumulative impacts are predicted as this supply-side action will be putting water into the system, rather than abstracting water from the River Dee.

4.6 Summary of Moderate and Major Impacts

The environmental assessment has identified no moderate or major impacts from the augmentation of the River Dee from the Lower Pen-y-Cae Reservoir, with the potential exception of a moderate positive impact on Bullhead, Sea Lamprey and other rheophilic fish species in the River Eitha through the maintenance of flows from the release of water during drought conditions.

5.0 Mitigation and Compensation

As no moderate or major impacts are predicted there is not a requirement for any mitigation or compensation measures to be implemented to prevent or minimise any impact.

However, to ensure compliance with the Animal Welfare Act 2006 (as amended) regular visual checks will be made for any stranded fish or fish in distress (e.g. gasping, trapped, dead fish) as the Lower Pen-y-Cae Reservoir water levels recede, and consideration will be made to capture and relocate fish, where deemed necessary and appropriate, to ensure statutory compliance.

6.0 Environmental Monitoring Plan

The augmentation of the River Dee from the Lower Pen-y-Cae Reservoir has the potential for a low magnitude impact on the River Eitha due to changes in water quality. It is proposed, therefore, that the Environmental Monitoring Plan will be based on gaining a better understanding of the environmental risk from the release of water from the Lower Pen-y-Cae Reservoir to the Trefechan Brook and River Eitha.

Table 26 provides a summary of the Environmental Monitoring Plan, including baseline, pre-drought, during-drought and post-drought monitoring. Please refer to Figure 5 in Section 4.2.3 for the proposed monitoring locations. The parameters to test for water quality are provided in Appendix A.

Table 26: Environmental Monitoring Plan

Parameter	Location	Monitoring			
		Baseline	Pre-drought	During-drought	Post-drought
Water quality (temperature, pH, dissolved oxygen, conductivity, suspended solids, BOD, ammonia, phosphate, orthophosphate, total oxidised nitrogen)	Lower Pen-y-Cae Reservoir (inflow and close to dam) Trefechan Brook (outflow of temporary pumping station and Bridge Street d/s of reservoir) River Eitha (u/s and d/s of confluence of Nant y Crogfryn, bridge at Afoneitha Road, Pen-y-Cae and upstream of the A483 in Ruabon)	Initially monthly sampling covering a whole calendar year but to be reviewed as to whether seasonal sampling would be appropriate	Bi-weekly on the initiation of any Stage 1 Drought General Directions meeting	Weekly during any augmentation releases	Bi-weekly for two weeks followed by the standard baseline monitoring
Water quality (aluminium, cadmium, copper, iron, lead, magnesium, manganese, nickel, sulphide, sulphate, zinc, dissolved organic carbon, chlorophyll, chlorophyta, cyanobacteria, other algae and bacillariophyta)	Lower Pen-y-Cae Reservoir (inflow and close to dam) Trefechan Brook (outflow of temporary pumping station and Bridge Street d/s of reservoir) River Eitha (upstream of the bridge at Afoneitha Road, Pen-y-Cae and upstream of the A483 in Ruabon)	Seasonal sampling (spring, summer, autumn and winter)	Weekly on the initiation of any Stage 1 Drought General Directions meeting	Weekly during any augmentation releases	Weekly for two weeks followed by the standard baseline monitoring
Macroinvertebrates (based on standard sampling of three minutes kick-sampling and one minute searching of stones / vegetation etc and analysis in accordance with assessing WFD ecological status, i.e. WHPT and NTaxa)	River Eitha (upstream of the A483 in Ruabon)	Seasonal sampling (spring, summer, autumn and winter)	Not required	Seasonal sampling (spring, summer, autumn and winter)	Seasonal sampling as per baseline monitoring

Glossary of terms

Term	Definition
Abstraction	Removal of water from a source of supply (surface or groundwater).
Abstraction licence	The authorisation granted by the Environment Agency or Natural Resources Wales to allow the removal of water.
Augmentations	The support of a river by an additional supply.
Catchment	The area from which precipitation and ground water will collect and contribute to the flow of a specific river.
Compensation flow	Water released from reservoirs in order to maintain a certain flow or level further downstream of the river.
Dee Consultative Committee	A committee which comprises NRW, EA, United Utilities, Dŵr Cymru Welsh Water, Hafren Dyfrdwy, Severn Trent Water and, Canal and River Trust. The committee supports Natural Resources Wales in the establishment and the implementation of operational control rules known as the Dee General Directions.
Dee Drought Directions	Specifies the principles and detail under which the prescribed flows and abstractions must be reduced in a drought more severe than the design drought.
Dee General Directions	A set of principles which detail the regulation of the River Dee, using Llyn Tegid, Llyn Celyn and Llyn Brenig Reservoirs.
Dee Normal Directions	Specifies the principles and detail under which the prescribed flows are maintained in the River Dee under normal operations.
Demand	The amount of water required for use including customer demand and leakage.
Dissolved Oxygen Levels	A relative measure of the amount of oxygen that is dissolved within water.
Drought	A general term covering prolonged periods of below average rainfall resulting in low river flows and/or reservoir levels and/or low recharge to groundwater. These conditions impose a significant strain on water resources and potentially the environment.
Drought Order	A means where Water Companies and/or Natural Resources Wales apply to Welsh Ministers for the imposition of restriction on the uses of water or to take water from a source.
Drought Permit	Issued by Natural Resources Wales in order to allow a Water Company to abstract water outside of the normal terms of an Abstraction Licence during a drought period.
Drought Trigger	A specific event/incident which triggers a drought action to occur.
Emergency Drought Order	A means by which a Water Company can restrict the supply of water to its customers through the imposition of rota cuts and/or the introduction of standpipes to deal with the very remote possibility of an extreme drought.
Gauging station	A site where the flow of a river is measured.
Groundwater	Water that is contained in underground rocks.
Habitat	Place in which a species or community of species live, with characteristic plants and animals.
HRA	Habitats Regulations Assessment – Process for identifying the implications of the drought plan options for European designated sites (SAC, SPA and Ramsar).
Hydrology	The study of the Earth's water, in particular of water under and on the ground before it reaches the ocean and before it evaporates.
Ml/d	Mega litres per day (Mega – million)
NRW	Natural Resources Wales
pH	pH is a measure of the acidity of an aqueous solution. Pure water is neutral, with a pH close to 7 whilst solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are basic or alkaline.

Term	Definition
Ramsar site	Ramsar sites are wetlands of international importance designated under the Ramsar Convention. More formally known as "The Convention of Wetlands of International Importance especially as Waterfowl Habitat", it is an intergovernmental treaty signed in Ramsar, Iran in 1971.
Regulated river	A river where the flow is managed. This can be retention and/or augmentation through the addition of water from another source.
Water resource zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.
SAC	Special Area of Conservation – Designated under the EU Habitats Directive. Together with SPAs these form the Natura 2000 network of protected sites.
SPA	Special Protection Area – Designated under the EU Directive on the conservation of wild birds. Together with SACs these form the Natura 2000 network of protected sites.
SSSI	Site of Special Scientific Interest – Designated under the Countryside and Rights of Way (CRoW) Act 2000.
STW	Severn Trent Water PLC
Turbidity	A measure of the cloudiness/haziness of water.
UKWIR	United Kingdom Water Industry Research Limited – Organisation jointly funded by all UK water and wastewater service suppliers.

Appendix A – List of water quality parameters to be measured during monitoring programme

Parameters
Iron dissolved µg/l
Manganese dissolved µg/l
Aluminium dissolved µg/l
Calcium total mg/l – in watercourses only
Magnesium total mg/l – in watercourses only
Dissolved lead µg/l
Nickel dissolved µg/l
Zinc dissolved µg/l
Cadmium dissolved µg/l
Turbidity NTU units
D.O. (% and mg/l)
Conductivity uS/cm
pH pH units
Copper dissolved µg/l
Total Phosphate – in reservoir only
Orthophosphate mg/l – in reservoir and watercourses
Ammonia mg/l
Temperature ℃
Suspended solids mg/l
Dissolved Organic Carbon mg/l – in watercourses only
Total Oxidised Nitrogen mg/l
Chlorophyll µg/l - in reservoir only
Sulphide – in reservoir only
Sulphate – in reservoir only
Chlorophyta
Cyanobacteria
Other algae area
Other algae cell
Total algal count
Bacillariophyta

RHAGOROL O'R TAP
WONDERFUL ON TAP

HAFREN
DYFRDWY
severn dee