Dŵr Cymru Welsh Water

Environmental Assessment of Afon Aled Drought Permit (8012-4)

Final

March 2019

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NON-TECHNICAL SUMMARY

INTRODUCTION AND PURPOSE OF THIS REPORT

Welsh Water's Drought Plan provides a comprehensive statement of the actions Welsh Water will consider implementing during drought conditions to safeguard essential water supplies to customers and minimise environmental impact. It encompasses a number of drought management options that will only be implemented if and when required and includes drought permit / order options.

A drought permit or order is a management action that, if granted, can allow more flexibility to manage water resources and the effects of drought on public water supply and the environment.

The objective of this report is to provide an independent and robust assessment of the potential environmental effects of implementing a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Aled Isaf Reservoir is located on the mainland, in the Clwyd Coastal region. The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

The assessment also considers how the proposed drought permit may affect the environment in combination with the effects of other existing abstraction licences, environmental permits and other drought management plans.

This report is a 'shelf-copy' report which would be updated to support an application to Natural Resource Wales (NRW) for a drought permit at Afon Aled, which may be required by Welsh Water in the future.

PROPOSED DROUGHT PERMIT DETAILS

In order to protect public water supplies within Welsh Water's Clwyd Coastal WRZ in the event of a future severe drought, Welsh Water would make an application to NRW for a drought permit to vary the conditions of abstraction from the Afon Aled / Plas Uchaf and Dolwen Reservoirs.

If granted, the drought permit involves a proposed relaxation of the annual licence conditions on the Bryn Aled intake and Plas Uchaf and Dolwen Reservoir abstraction, to enable Welsh Water to abstract from the Aled catchment at high demands of up to the daily licensed maximum rates, to meet higher than usual demands in drought conditions.

This flow reduction will conserve the longevity of reservoir storage for direct supply to Welsh Water's customers during an environmental drought and also improve the probability of winter refill of the reservoir. The drought permit will influence the Afon Elwy downstream of Afon Aled and the four reservoirs within the catchment.

The drought permit is most likely to occur during the autumn and winter period, and is considered not to extend outside the period November to March. This has been confirmed by Welsh Water's water resources modelling.

The revised abstraction arrangements would legally be authorised for five months but would be removed sooner if water resources have returned to adequate levels to safeguard future water supplies, as agreed with the Welsh Ministers / NRW.

NEED FOR THE DROUGHT PERMIT

Application for a drought permit is a precautionary approach. Due to the time needed to determine a drought permit application, Welsh Water will potentially apply for a drought permit more frequently than it will be used.

The justification for the drought permit sought will be set out in a "Needs Statement". This will be produced by Welsh Water at the time of a potential future application, and will form part of the full drought permit application.

ALTERNATIVE SOURCES CONSIDERED

Details of alternative sources considered by Welsh Water will be completed at the time of application for the drought permit at Afon Aled / Plas Uchaf and Dolwen reservoirs. This will demonstrate justification for the proposed drought option details applied for.

POTENTIAL IMPACTS OF DROUGHT PERMIT IMPLEMENTATION

The scope of the assessment has been defined by a screening and scoping exercise.

Summary of the Hydrological Assessment

The assessment has concluded that there is a **minor** impact on flows in the Afon Aled as a result of implementing the drought permit. Impacts on the, Dolwen Reservoir and Plas Uchaf Reservoir have been assessed as **major, and impacts on** Aled Isaf and Llyn Aled are assessed as minor. These hydrological impacts are assessed as leading to major impacts on the physical environment of the river, including water quality.

Summary of the Environmental Features Screening

Environmental assessment is required and included for features where screening has identified a major or moderate impact.

Screening identified WFD status and Community Assessment / Habitats Directive designated habitats and species, macroinvertebrates, phytobenthos, phytoplankton, landscape and recreation as environmental features for which an environmental assessment was required.as environmental features for which an environmental assessment was required.

The assessment has concluded that there are **minor to moderate** impacts on fish, macroinvertebrates, and macrophytes and **negligible** impacts on phytoplankton in the Plas Uchaf and Dolwen Reservoirs.

Cumulative Impacts

No cumulative effects of implementing the drought permit with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs.

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs. Consequently, in line with the DPG, an Environmental Monitoring Plan has been proposed. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

CONCLUSIONS

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs during November to March inclusive, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **moderate**.

Contents

Non-Technical Summary

1 INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL ASSESSMENT

The objective of this Environmental Assessment Report (EAR) is to provide an independent and robust assessment of the potential environmental effects of the implementation of a drought permit by Dŵr Cymru Welsh Water (Welsh Water) to relax the annual licence conditions on the Bryn Alde intake and Plas Uchaf and Dowlen Reservoir abstraction, to enable Welsh Water to abstract from the Aled catchment at high demands of up to the daily licensed maximum rates, to meet higher than usual demands in drought conditions. Water abstracted from Afon Aled is used to provide public water supplies to Welsh Water's Clwyd Coastal Water Resource Zone (WRZ) (see Section 2.1).

This EAR is a 'shelf-copy' report which would be updated in the event that Welsh Water needs to make an application during any future drought to Natural Resources Wales (NRW) for a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs. A drought permit is a management action that, if granted, can help ensure essential water supplies are maintained to homes and businesses. The circumstances under which a drought permit may be required is set out in the Welsh Water Drought Plan.

The assessment presented in this EAR considers the effects of implementation of the drought permit over the months of November to March inclusive, the period for which Welsh Water has determined it might require a drought permit for this water source. The purpose of the assessment is to determine the environmental impacts of the drought permit over and above any effects arising from natural drought conditions.

The study area and focus of this environmental assessment of the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit, covers the following waterbodies:

- Aled - Elwy to Deunant (GB110066059770)
- Plas Uchaf and Dolwen Reservoirs (GB31033261)

This EAR includes discussion of the following:

- an assessment of the likely changes in river flow / water level regime due to implementing the proposed drought permit (**for a summary, see Section 4 of this report**)
- identification of the environmental features that are sensitive to these changes and an assessment of the likely impacts on these features (**see Section 5 of this report**)
- identification of mitigation measures that may be required to prevent or reduce impacts on sensitive features (**see Section 6 of this report**)

- recommendations for baseline, in-drought and post-drought permit monitoring requirements (**see Section 9 of this report**).

The environmental assessment has been conducted in accordance with Government regulations and using the Welsh Government / NRW Drought Plan Guideline[1] (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders[2].

Consideration has been given to the potential impacts of drought permit implementation on statutory designated sites, including those designated under international law (Habitats Directive, Birds Directive and the Ramsar Convention) and national legislation (notably Sites of Special Scientific Interest (SSSIs).

In accordance with the DPG, the assessment also considers how the proposed drought permit may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other relevant activities and plans. This is discussed further in Sections 3 and 7.

1.2 SUPPORTING STUDIES

The DPG identifies in Section 5.4 that EARs are required as supporting documents to any drought permit or drought order application. The circumstances for which an environmental assessment is required are set out in **Box 1** below.

Box 1: Drought Plan Guidance - requirement for environmental assessment

The DPG requires that all features that could be affected by implementation of a drought order /permit are listed in the EAR and that an assessment is made of how sensitive each feature is to the likely changes in hydrology, hydrogeology and geomorphology, due to implementing the drought order /permit.

The DPG requires a detailed environmental assessment for applications where sensitive features are likely to be subject to a major or moderate impact, or a minor impact where this applies to environmentally designated features. Further environmental assessment is **not** required for those drought orders / permits where there is certainty that there are no such impacted sensitive features.

This environmental assessment is based on data available at the time of writing and includes the environmental features and data types determined by Box 1 in Appendix I of the DPG (except where these are considered not to be relevant to this drought

[1] Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000, Accessed 04 February 2019.
[2] Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, https://www.gov.uk/government/collections/apply-for-a-drought-permit-drought-order-or-emergency-drought-order Accessed 21 December 2018.

permit). Data were requested from key consultees (including NRW).

Where appropriate, this report also identifies areas where there are deficiencies in data availability and makes recommendations for future data / information gathering and monitoring. Welsh Water will continue to engage closely with NRW to ensure that adequate and sufficient data / information are collated and kept up-to-date in subsequent years to inform future environmental assessments.

1.3 CONSULTATION

Consultation is identified as an essential exercise in the preparation of the EAR. In preparing this 'shelf-copy' EAR for a drought permit at Afon Aled / Plas Uchaf and Dolwen reservoirs, consultation with regulators and wider stakeholders has been undertaken to gain feedback on potential adverse effects, gather data and discuss any required monitoring and / or mitigation measures.

Further consultation will be also be undertaken at the time of any future applications for the drought permit.

1.4 STRUCTURE AND CONTENT OF THE REPORT

This EAR comprises the following sections:

Section 1: Introduction

Section 2: Background to the Drought Permit

Section 3: Approach

Section 4: Hydrology and the Physical Environment

Section 5: Environmental Features Assessment

Section 6: Mitigation

Section 7: Cumulative Impacts

Section 8: Summary of Residual Impacts

Section 9: Environmental Monitoring Plan (EMP)

Section 10: Conclusions

2 BACKGROUND TO THE DROUGHT PERMIT

2.1 WELSH WATER'S SUPPLY SYSTEM

Welsh Water supplies water to more than 3 million people. The Welsh Water supply area covers the majority of Wales and a small part of England. It is split into 24 WRZ's (see **Figure 2.1**).

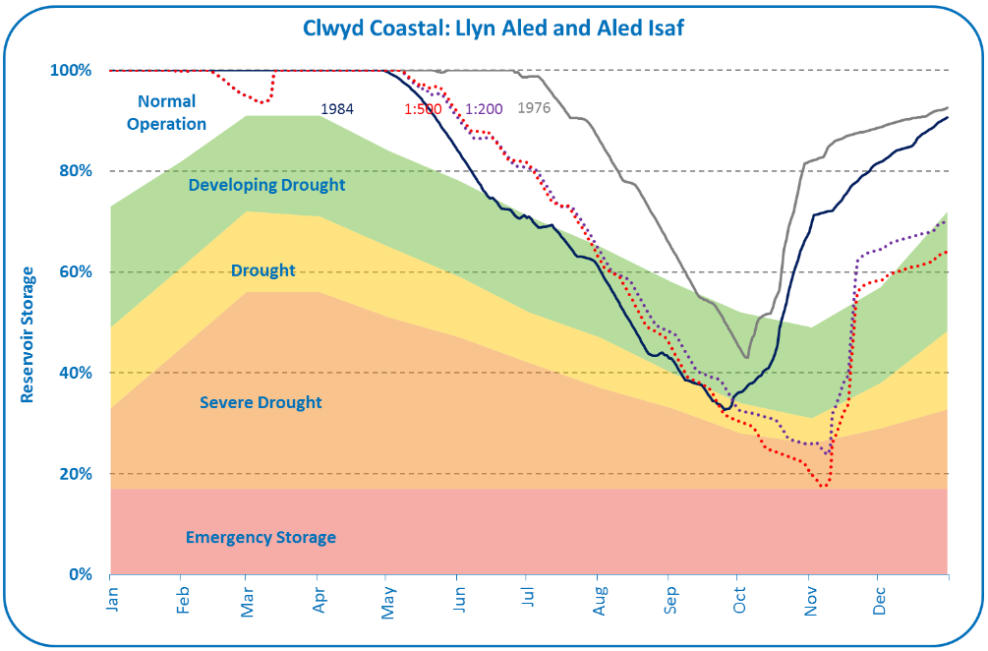
Figure 2.1 Welsh Water Water Resource Zones

Aled Isaf Reservoir is located on the mainland, in the Clwyd Coastal region. The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

The trigger levels for applying for a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs are based on combined reservoir storage in Aled Isaf and Llyn Aled, falling below a defined level; this is shown in **Figure 2.2** (orange shading labelled as 'severe drought'). Welsh Water's assessment in its draft Drought Plan 2020 indicates that drought conditions severe enough to require an application for this drought option

are unlikely to occur more frequently than at a return period of around once every 200 years. Fuller details of the work undertaken to assess this risk are provided in Annex 1 to the draft Drought Plan 2020.

Figure 2.2 Clwyd Coastal WRZ : Afon Aled Drought Action Zones and Historic Droughts



2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT AFON ALED

Welsh Water abstract water from the Afon Aled at Bryn Aled intake to pump to Plas Uchaf Reservoir. From Plas Uchaf Reservoir water gravitates to Glascoed Water Treatment Works, which supplies the Clwyd Coastal water resources zone (WRZ) (average demand 19.8Ml/d in 2012/13). The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions:

- 4,318 million litres (Ml) authorised to be abstracted per annum
- Maximum daily abstraction rate of 27.3Ml/d
- The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following:
    - A fixed statutory compensation water discharge of 2.27Ml/d at all times for the general benefit of riparian interests
    - Regulation releases to support the abstraction at Bryn Aled that include the following scenarios

- 1 February to 31 May inclusively when the Bryn Aled intake is in operation: controlled releases from Aled Isaf Reservoir maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake

- 1 June to 31 January inclusively when flow at Bryn Aled weir is less than 29.5Ml/d: daily regulation releases from Aled Isaf Reservoir shall not be less than the daily abstraction rate at Bryn Aled intake

- Fisheries management and angling releases. These are made up of a maximum of 354Ml for freshet releases and an additional special release allocation, the volume of which varies each month depending on the reservoir levels (see S20 operating manual).

The abstraction of water is taken from the Afon Aled at the Bryn Aled intake and transferred to Plas Uchaf impounding reservoir. Water from Plas Uchaf reservoir is abstracted and treated at Glascoed water treatment works (WTW) for public supply. Abstraction at the Bryn Aled intake is typically continuous during the summer and autumn period. The abstraction rate is typically 9.2Ml/d, the capacity of the smaller of the two abstraction pumps. The bigger, variable speed pump is used for larger abstractions when required, up to 16Ml/d. In winter, abstractions are still required to support the potable supply but are made at a lower rate.

Compensation, regulation and freshet releases from Aled Isaf Reservoir are controlled through a series of manually operated valves on the reservoir drawoff tower. These are measured prior to release to the Afon Aled.

Freshet releases are made from a bank of water reserved in the licence under the terms of the Section 20 Operating Agreement with NRW. Welsh Water control the basic fisheries release seasonally. Fisheries releases are specified by NRW but typically a flow of 3.8Ml/d is released continuously during the period 1 July to 15 September and a flow of 2.0Ml/d is released continuously during the period 16 September to 16 October. Outside these periods NRW can request additional freshet releases from 1 April, providing they are within the maximum allocation of 354 Ml.

During the period 28 August to 25 January, a series of valves in the Aled Isaf Reservoir drawoff tower are kept open for flood mitigation. These releases are also made through the flow measurement structure. At high reservoir levels (above the spillway crest level) excess water spills from Aled Isaf Reservoir to the Afon Aled.

Llyn Aled Reservoir is located approximately 1km upstream of Aled Isaf Reservoir on the Afon Aled. Together, these two reservoirs provide a total live storage volume of 2,862Ml for controlling releases to the Afon Aled from Aled Isaf Reservoir. There are

no licensed controls on the operation of Llyn Aled Reservoir. Water is released through a manually operated drawoff from Llyn Aled Reservoir and flows through an open channel (a channelised section of the Afon Aled) to Aled Isaf Reservoir. Releases should only be made when the level in Aled Isaf Reservoir drops below 10 metres and subsequent releases should then be made to maintain the level between 8 and 10 metres.

Welsh Water also has two licences for the abstraction of water from local streams to supplement inflow to Llyn Aled Reservoir. These licences are not affected by this drought permit.

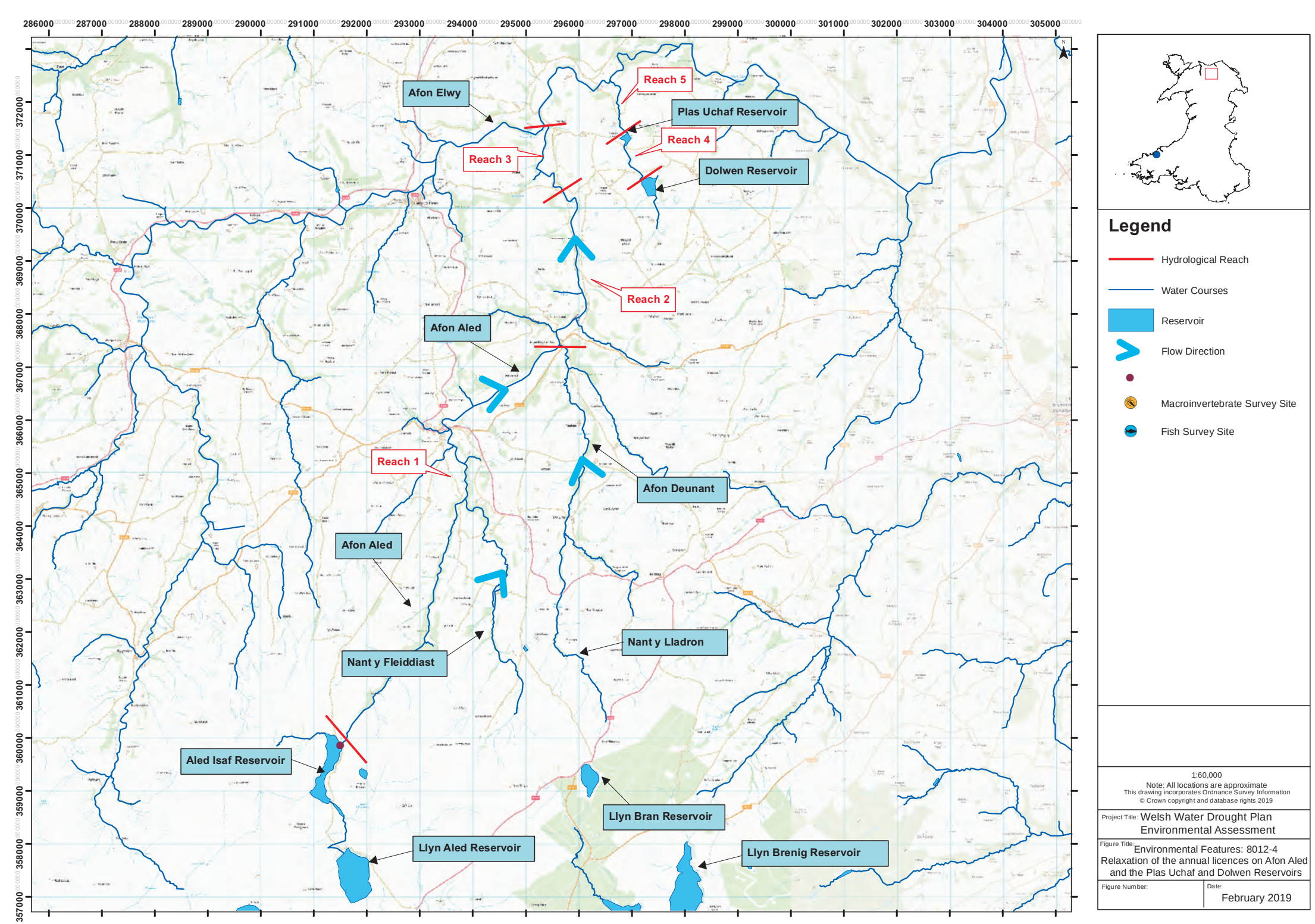
The Plas Uchaf Reservoir and Dolwen Reservoir abstraction licence (number 24/66/6/7/S, variation no. 2) includes the following conditions:

- 5000 million litres (Ml) authorised to be abstracted per annum.
- Maximum daily abstraction rate of 22Ml/d.

There are no statutory compensation release requirements relating to the abstractions from Plas Uchaf and Dolwen reservoirs.

The annual licences on Bryn Aled intake and Plas Uchaf and Dolwen reservoirs can support annual average abstractions of up to 11.8Ml/d and 13.7Ml/d respectively.

The study area is illustrated on **Figure 2.3**.



Legend

- Hydrological Reach
- Water Courses
- Reservoir
- Flow Direction
- Macroinvertebrate Survey Site
- Fish Survey Site

1:60,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Features: 8012-4 Relaxation of the annual licences on Afon Aled and the Plas Uchaf and Dolwen Reservoirs

Figure Number:

Date: February 2019

2.3 WELSH WATER'S DROUGHT PLANNING PROCESS

Water companies in England and Wales are required to prepare and maintain Statutory Drought Plans under Sections 39B and 39C of the Water Industry Act 1991, as amended by the Water Act 2003, which set out the management and operational steps a water company will take before, during and after a drought. The Water Industry Act 1991 defines a drought plan as '*a plan for how the water undertaker will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water,* with *as little recourse as reasonably possible to drought orders or drought permits*'.

The Drought Direction (Wales) 2017 states that revised Drought Plans should be submitted according to the following schedule:

> *4(b) for a revised drought plan –*
>
> *if section 39B(6)(a) of the Act applies, within 6 months after the date on which the material change of circumstances occurs; and*
>
> *if section 39B(6)(c) of the Act(c) applies, no later than 4 years after the date on which its drought plan, or its last revised drought plan, is published.*

2.4 STATEMENT OF THE NEED FOR DROUGHT PERMIT

This section will be completed at the time of application for a drought permit.

2.5 DROUGHT PERMIT– REGULATORY ARRANGEMENTS

In periods of unusually low rainfall, when water resources become scarce, the Water Resources Act 1991, as amended by the Environment Act 1995 and the Water Act 2003, allows for three mechanisms for temporarily augmenting water supplies from rivers, lakes, reservoirs and groundwaters: drought permits; ordinary drought orders; emergency drought orders.

Drought permits are granted by NRW, and allow a water company powers to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences. Drought orders are granted by the Welsh Ministers and give powers either to a water company or to NRW to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences, but also to allow the discharge of water to specified places, modify or suspend conditions relating to a discharge or prohibit or limit particular non-essential uses of water as set out in the Drought Plan (Wales) Direction 2017. Emergency drought orders grant the same powers as a drought order, but in addition, confer powers to prohibit or limit water uses as specified by the water company and allow the set up and supply of water by means of standpipes and/or water tanks or rota cuts.

Drought permits and orders may be granted for a period of up to six months and they can be extended for up to a further six months.

As part of the drought order/permit application process, water companies are required to prepare an Environmental Report setting out anticipated effects of the proposal, including the effect on other abstractors and sufficient information to inform assessments, where applicable, in relation to the Habitats Directive, Countryside and Rights of Way Act (CRoW), and the Water Framework Directive (WFD).

Further information on the requirements for the environmental assessment and reporting according to legislation and national guidance are provided in Section 3.

2.6 REVIEW OF ALTERNATIVE OPTIONS

This section will be completed at the time of application for a drought permit, setting out the alternative options to the drought permit that Welsh Water has considered in addressing the risks to essential public water supplies due to drought.

2.7 PROPOSED DROUGHT PERMIT DETAILS

In order to protect essential public water supplies within Welsh Water's Clwyd Coastal WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit to vary the conditions of its abstraction licence from Afon Aled / Plas Uchaf and Dolwen Reservoirs.

If granted, the drought permit involves a relaxing the annual licence conditions on the Bryn Alde intake and Plas Uchaf and Dowlen Reservoir abstraction, to enable Welsh Water to abstract from the Aled catchment at high demands of up to the daily licensed maximum rates, to meet higher than usual demands in drought conditions. The drought permit scheme will potentially influence water levels in Llyn Aled, Aled Isaf, Plas Uchaf and Dolwen Reservoirs and flows in the Afon Aled and Dolwen/Plas Uchaf catchments.

The drought permit is most likely to occur during the autumn-winter period, considered to not extend outside the period November to March. This has been confirmed by Welsh Water's water resources modelling.

Table 2.1 Afon Aled Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit Ml/d
Afon Aled	SN 03737 24275	The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions: ○ 4,318 million litres (Ml) authorised to be abstracted per annum ○ Maximum daily abstraction rate of 27.3Ml/d ○ The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following: o A fixed statutory compensation water discharge of 2.27Ml/d at all times for the general benefit of riparian interests Regulation releases to support the abstraction at Bryn Aled.	The drought permit involves a relaxing the annual licence conditions on the Bryn Alde intake and Plas Uchaf and Dowlen Reservoir abstraction, to enable Welsh Water to abstract from the Aled catchment at high demands of up to the daily licensed maximum rates, to meet higher than usual demands in drought conditions.	5 Ml/d

[Note: it will probably be necessary to remove the NGR for any public domain version]

2.8 DROUGHT PERMIT PROGRAMME

Drought actions and any future application for a drought permit would be managed by the Aled and Clwyd Consultative Group which would be convened under the terms of the Section 20 Operating Agreement with NRW. Decisions around which permit to apply for in the Clwyd Coastal WRZ will be made in liaison with the Section 20 consultative groups to ensure the best option for the environment and water resource situation is chosen.

Drought permits can be granted for a period of up to six months, and they can be extended for up to a further six months. However, the period of implementation for this drought permit is restricted to November to March, as confirmed by water resources modelling carried out by Welsh Water.

Prevailing weather conditions and rainfall in the intervening period may delay the requirement for applications, or even result in no requirement to apply. A drought permit may be granted but not actually implemented if weather conditions improve or, equally, the permit may only be partially implemented.

2.9 DROUGHT PERMIT BASELINE

It is important for the assessment to establish the environmental "baseline" conditions that would exist in drought conditions but in the absence of the drought permit being implemented. For the purposes of this assessment, the "without drought permit" baseline includes the continuation of abstraction from Afon Aled in accordance with the abstraction licence conditions, including continuation of daily abstraction at Bryn Aled intake on Afon Aled, for transfer to Plas Uchaf Reservoir for potable supply, under normal licence conditions and operating arrangements including compensation, fisheries and regulation releases from Aled Isaf Reservoir

3 APPROACH

3.1 INTRODUCTION

The DPG states that the environmental report must include:

i. the likely changes in flow, level, channel/riparian form and sediment due to implementing the action;
ii. the features that are sensitive to these changes;
iii. potential impacts on sensitive features;
iv. a plan of baseline, in-drought and post-drought monitoring; and
v. mitigation or compensation measures that may be required

Items i and ii above were subject to an initial screening process as part of the scoping exercise. Section 3.2 below describes the approach taken. This has provided the relevant study area and a list of features scoped into the environmental assessment which are the subject of this EAR.

Section 3.3 describes how the environmental assessment has been undertaken, including discussion of the general approach, guidance used, provision of data, assessment methodologies and consideration of mitigation and monitoring. Limitations to the environmental assessment are described in Section 3.4, 4 and 5.

To set the context of the studies, it should be noted that EAR considers the environmental impacts of implementing a drought permit during the worst environmental conditions (natural drought) that the permit could be implemented in.

In accordance with the DPG and the Habitats Regulations, the assessment considers how the proposed drought permit may affect the environment in combination with the effects of other existing abstraction licences, environment permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction and discharge consents
- Assessment of cumulative impacts of the drought permit with other Welsh Water supply side and drought permit / order options within the hydrological zone of influence (including both intra- and inter- zone options)
- Other plans and projects of relevance, including:
    - Welsh Water's WRMP schemes which are scheduled to be implemented and become operational within the time period of the revised Drought Plan (i.e. before 2025)

- Drought options from other neighbouring water company Drought Plans, NRW Drought Plans
- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

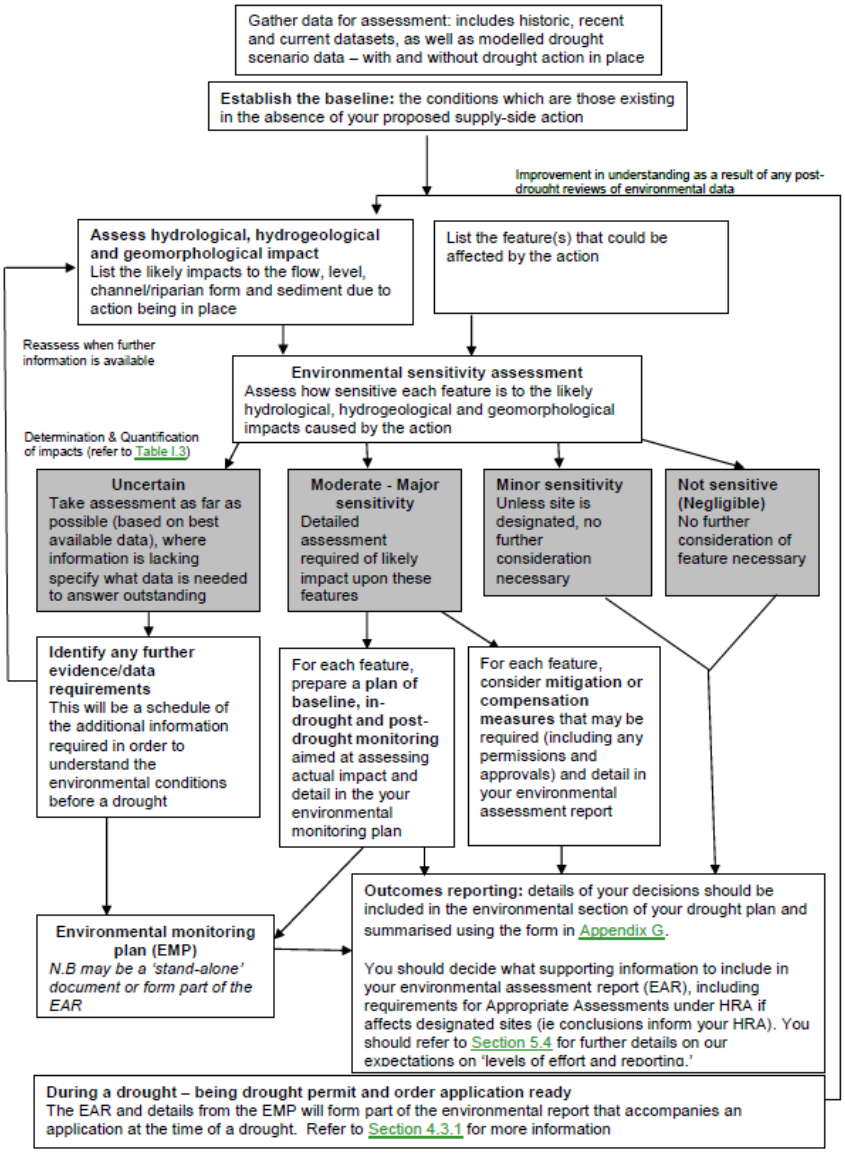
This is discussed further in Section 7.

3.2 APPROACH TO SCREENING AND SCOPING

3.2.1 Screening

Screening was undertaken using the DPG; specifically Section 5 and Appendix I. Figure 2 of the DPG (replicated in **Figure 3.1** below) identifies the environmental impact activities required.

Figure 3.1 Environmental Impact Activities Identified in the Drought Plan Guideline



The screening fulfils the requirement to "Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action". Stage 1 (hydrological impact) fulfils the requirement to "List the likely impacts to the flow, level, channel/riparian form and sediment due to action being in place". Stage 2 (environmental sensitivity) fulfils the requirement to "list the feature(s) that could be affected by the action" and to "Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action"

It is important to acknowledge the basis of the assessment; i.e. impacts of drought permit implementation should be considered in the context of what would occur without drought permit implementation (see Sections 2.2, 2.7 and 2.9).

The approach to undertaking Stages 1 and 2 is described below.

Stage 1 – Hydrological and Hydrogeological Impact

Consideration is required (by the DPG) of the likely impacts on the hydrology, hydrogeology and geomorphology of every river reach, wetland or lake area influenced by the proposed drought management action, specifically:

- identify the drought conditions which trigger the proposed action;
- identify any changes that the action is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features;
- describe the likely conditions in the absence of the proposed action;
- describe how the likely conditions would differ with the action in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by the planned actions.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see below) to identify the environmental risk of implementing the drought permit.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix I of the DPG), it does not provide a methodology for identifying the hydrological impact. A bespoke assessment has therefore been undertaken.

The full hydrological assessment approach is set out in **Appendix A**.

The output from these studies provides an understanding of the scale of change in the

hydrological characteristics as a result of implementing the drought permit. Where changes have been identified, the potential significance of adverse or beneficial impacts has been assessed.

Quantitative and qualitative measures have been used to grade the impacts on surface waters. The assessment has identified the potential severity of impact based on the following criteria:

- **Positive or Negative Impact** – all impacts are considered to be negative unless otherwise stated in the feature assessment.
- **Extent** – the extent of the impact is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified as**:**
  - *High*: There is a long-term large-scale (i.e. catchment) change in the physical environment.
  - *Medium*: There is a short-term large-scale change or long-term short-scale (i.e. reach) change in the physical environment, however, no changes in the overall integrity of the physical environment.
  - *Low*: There is a short-term small-scale change in the physical environment, but its overall integrity is not impacted.
  - *Negligible*: No perceptible change in the physical environment.
- **Duration** – the duration of impact is considered to be for 6 months, which is the duration for which a drought option is implemented, unless otherwise stated.
- **Reversibility** – all hydrological impacts are considered to be reversible**.**
- **Timing and Frequency** – the drought option could be implemented at any point in the year, unless otherwise stated. The assessment is based upon the operation of a single drought permit, with subsequent applications for a drought permit required to consider cumulative effects of multiple drought permit.
- **Probability** – all impacts are considered to be probable, unless otherwise stated.

The hydrological impact assessment is described fully in **Appendix B**.

Section 4 provides a summary of the hydrology and physical environment assessment as a result of implementing a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs.

Stage 2 - Environmental Sensitivity

With the extent and level of flow impact mapped, using GIS and other data sources, potentially sensitive receptors (sites / features) located within the extents of impact

have been identified. Potentially sensitive features investigated in the screening have been drawn from Box 1 in Appendix I of the DPG. These include:

- designated biodiversity sites (Local Nature Reserve (LNR), National Nature Reserve (NNR), Marine Protected Areas, National Parks, Areas of Outstanding Natural Beauty (AONB), SSSI, Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar) and Environment (Wales) Act Section 7 species / habitats which are located on or within 500m of the impacted reaches;
- protected species;
- ecological communities (fish, bryophytes & lichen, macro-invertebrates, macrophytes, algae) and, where identified, Water Framework Directive (WFD) status of designated waterbodies which contain the impacted reaches;
- invasive non-native species;
- sensitive ecological features as advised by NRW;
- wider features which should be taken into account in determining the potential impacts of drought option implementation – specifically socio-economic & health, amenity & aesthetics, recreation, navigation, architectural & archaeological heritage.

Each of the identified sensitive receptors within the extent of impact have been listed, alongside a brief summary of their potential susceptibility to flow impacts. For designated sites, this has included an indication as to whether the sites have water dependent qualifying interests.

The environmental sensitivity of each site has been identified according to the ecological and nature conservation interests of the area and, in particular, the proximity of and / or connectivity with the designated protected area. Each site has been assessed according to whether the extent of hydrological influence includes or is considered to affect a designated or protected site. Designated or protected sites outside the extent of hydrological influence are considered not to be influenced by the drought permit.

The outcome of Stage 1 and Stage 2 of the screening exercise are presented in Sections 4 and 5 respectively.

3.2.2 Scope

The screening exercise establishes the study area for the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit together with identification of relevant, sensitive environmental features within those study areas (based on the risk of them being impacted by the drought permit during the period of its operation).

As set out in **Figure 3.1**, the environmental sensitivity screening identifies the outcome for each listed feature. Four outcomes are possible from the screening: uncertain; moderate-major sensitivity; minor sensitivity; not sensitive (negligible); and identifies appropriate next steps. Sections 4.2 and 5.2 present the findings which show that a number of features were identified as either: 1) uncertain; 2) moderate-major sensitivity; or 3) minor sensitivity in a designated site and in accordance with the DPG are features for which further assessment work will be required. These features alone form the scope of monitoring, environmental assessment, and consideration of mitigation actions.

The DPG states that environmental assessment, mitigation and / or monitoring is not required for features where screening has identified a minor (unless a site is designated) or negligible impact. However, the requirement for assessment, monitoring and / or mitigation has been reviewed on a case-by-case basis. In some cases, mitigation and / or monitoring has been recommended where minor impacts are identified, where considered appropriate on a precautionary basis.

3.3 APPROACH TO ASSESSING IMPACTS, MITIGATION AND MONITORING

3.3.1 General Approach

The assessment approach is in accordance with legislation, national regulations and guidance, including:

- NRW (2017) Water Company Drought Plan Technical Guideline (DPG)
- Welsh Ministers (2017) The Drought Plan (Wales) Direction
- Institute of Environmental Management and Assessment (2004) Guidelines for Environmental Assessment
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland[3]
- UKWIR (2007, updated 2012) Strategic Environmental Assessment – Guidance for Water Resources Management Plans and Drought Plans. Prepared by Cascade Consulting
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds

[3] CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial. Freshwater and Coastal. September 2018.

- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975
- Conservation of Habitats and Species Regulations 2017
- The Countryside and Rights of Way Act 2000.

All aspects of the drought permit of potential environmental significance are considered in the environmental assessment.

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

In accordance with the DPG the approach to the assessment addresses the following: i) potential effects on each sensitive receptor; ii) definitions for impacts (adverse / beneficial); iii) the data requirements; iv) assessment methodology (including the treatment of uncertainty where the complete data requirements are not available).

This EAR presents the environmental baseline, i.e. habitats and environmental pressures (including flow and water quality) in the study identified zone of hydrological influence without the drought permit in place, utilising a description of the catchment, geomorphology, anthropogenic features and water quality. Key changes to the physical environment as a result of implementing the drought permit have been identified and described and, where appropriate, this information is used to frame and support the assessments of features which have been scoped in further to the screening and scoping exercise (see Section 3.2).

3.3.2 Assessment Methodologies

The aim of the Environmental Assessment is to provide:

- A clear summary of the outcome of each assessment (per feature) from which NRW can readily identify the significance of the impact when determining the drought permit application
- Identification of those predicted impacts which are to be taken forward to consider additional monitoring and mitigation actions.

The assessment considers the environmental impacts of implementing the drought permit against baseline operating conditions of Welsh Water's abstraction licence in advance of drought permit implementation. Environmental sensitivity has been assessed considering the context of the timing of drought permit implementation. **It is important to acknowledge the basis of the assessment; i.e. impacts of drought permit implementation are assessed against what would occur without drought permit implementation**.

The impact assessment for sensitive features is feature specific and is dependent on the availability and resolution of available data. Where possible, quantitative assessments have been undertaken. However, for many features, it is acknowledged that the assessments are qualitative and based on professional judgement, and using, where relevant, experience of local knowledge and reference to literature. This introduces uncertainty into the impact assessment. A precautionary approach has been used to assigning impact significance where data are absent or found not to be robust.

The assessment of impacts on designated sites has been undertaken using professional judgement with reference to conservation objectives and condition status of habitats and species, for which a site has been designated. The ecological assessment has been undertaken recognising the IEMA[4,5] and the CIEEM study guidelines[6]. The assessment of impacts on other environmental receptors e.g. recreation and landscape has been carried out largely by qualitative expert judgement.

Assessment of impacts on specific features has then been undertaken. Specific assessment methodologies have been developed for key environmental features. These are set out in **Appendix C** (assessment methodologies for the ecological assessment of Environment (Wales) Act Section 7 species, designated sites and other flora and fauna).

Other abstractors, including other water company abstractions, are features that have been reviewed within the assessment. This has been undertaken to determine whether other abstractors could potentially be affected by changes to surface water flows and levels as a result of implementation of the drought permit.

3.3.3 Mitigation and Monitoring

Section 5.3 of the DPG identifies the specific requirements for mitigation of serious impacts on the environment as a result of implementing a drought management measure. The assessments undertaken in this EAR confirm the features requiring consideration of mitigation and appropriate monitoring triggering mitigation. Appropriate mitigation actions identified are both available and practicable.

The DPG also identifies the specific requirements for monitoring. The assessments undertaken in this EAR inform the features requiring consideration for monitoring prior to, during, or after implementation of the drought permit.

The mitigation and monitoring proposals (see Sections 6 and 10) will act as a safeguard that responds and is responsive to both predicted and unpredicted drought impacts.

[4] IEMA (2004) Guidelines for Environmental Impact Assessment.
[5] IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK
[6] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

Future data collection and monitoring can then be focused to identify the aquatic ecosystem interaction to better quantify the potential impacts where gaps in the evidence base are identified and ensure the appropriate targeting of monitoring and mitigation response. The EMP will need to be finalised in agreement with NRW.

3.4 LIMITATIONS OF THE ASSESSMENT AND UNCERTAINTIES

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

The assessment presented in this document draws on available information from surveys and investigations undertaken by Welsh Water, NRW, as well as other bodies over a number of years. Reference has also been made to wider studies from published and grey literature, i.e. academic literature that is not formally published, where appropriate.

Specific details are provided on the quality of the data collected and used in the assessment. Where uncertainties remain with respect to the quantification and prediction of impacts, the limitations and any assumptions made are included in the relevant technical sections (Sections 4 and 5).

Overall, it is considered that the conclusions are based on information that is robust and valid at the time of writing. However, it should be noted that this EAR would be updated to support any future actual application, including a review of data.

4 AFON ALED DROUGHT PERMIT - HYDROLOGY AND THE PHYSICAL ENVIRONMENT

4.1 INTRODUCTION

Consideration of hydrology and the water physical environment sets the context for the potential range of environmental effects of the drought permit. **Appendix B** sets out an assessment of the potential impacts on the physical environment of Afon Aled / Plas Uchaf and Dolwen Reservoirs during the period of implementation of the drought permit. The "without drought permit" baseline is set out in Section 2.9.

The water physical environment assessment includes consideration of hydrology and hydrodynamics; geomorphology; and water quality. The assessment has three key objectives:

1. It is used to "list likely changes in flow, level, channel/riparian form and sediment due to implementing the action' as required by the DPG and set out in Figure 2 of the DPG
2. It is used to support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report
3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

Each of these are summarised below.

4.2 SUMMARY OF STAGE 1 SCREENING

This fulfils the DPG requirements of Stage 1 of the screening of potential drought permit impacts, identifying the likely changes in flow/ level regime due to implementing the drought permit. The specific requirements of the DPG are summarised as:

- identify any changes that the drought permit is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features (e.g. flow, water level, channel dynamics and sediment changes);
- describe the likely conditions in the absence of the drought permit;
- describe how the likely conditions would differ with the drought permit in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by your planned actions.

These requirements are addressed in the following sections.

1. The perceived extent of potential impact:
2. The study area (see **Figure 2.3**) is identified as the Afon Aled, Llyn Aled and Aled Isaf Reservoirs, and Plas Uchaf and Dolwen Reservoirs. The nature and duration of the potential impact:

A description of the likely conditions with the drought permit in place, in comparison to the baseline conditions (absence of the proposed action) is provided in **Appendix B**. Given the conditions of the proposed drought permit, the key areas for the assessment of the physical environment have been identified as:

- Change in river flows in the Afon Aled.

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the magnitude and duration of each of these potential physical environment impacts.

3. The length of the potential impact:

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the timing of each of the potential physical environment impacts. The drought permit is most likely to occur during the autumn and winter period, considered to not extend outside the period November to March.

4.3 SUMMARY OF POTENTIAL EFFECTS ON THE PHYSICAL ENVIRONMENT

The potential changes to the physical environment (water quality and geomorphology) due to implementation of the drought permit are summarised in **Table 4.1.** These impacts are presented in detail in **Appendix B**.

Table 4.1 Summary of Potential Hydrodynamic and Water Quality Impacts of the Drought Permit

Llyn Aled Reservoir	
Water levels in Llyn Aled Reservoir *Minor impacts during the period from February to March inclusive*	• No decrease in water levels, but an increase in the duration of the reservoir drawdown period of up to 53 days (22%)
Water Quality in Llyn Aled Reservoir *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Aled Isaf Reservoir	
Water levels in Aled Isaf Reservoir *Minor impacts during the period from February to March inclusive*	• No decrease in water levels, but an increase in the duration of the reservoir drawdown period of up to 53 days (22%)
Water Quality in Aled Isaf Reservoir *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Dolwen Reservoir	
Water levels in Dolwen Reservoir *Major impacts during the period November to December inclusive*	• Decrease in water levels of around 11% by the end of the year
Water Quality in Dolwen Reservoir *Medium risk during the period November to December inclusive*	• Medium risk to dissolved oxygen. No risk to ammonia.
Plas Uchaf Reservoir	
Water levels in Plas Uchaf Reservoir *Major impacts during the period November to December inclusive*	• Decrease in water levels of around 23% by the end of the year
Water Quality in Plas Uchaf Reservoir *Medium risk during the period November to December inclusive*	• Medium risk to dissolved oxygen. No risk to ammonia.
Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir	
River Flows in the River Aled *Minor beneficial impacts during the period from February to March inclusive*	• Continued regulation releases to support downstream abstractions during low flow periods would increase flows in Reach 1
Geomorphology *Negligible impacts during the period from February to March inclusive*	• Due to the minor beneficial hydrological impact of the reach, geomorphological variation due to the drought permit is not expected to go beyond the normal low flow drought regime.
Water Quality *Negligible risk during the period from February to March inclusive*	• Negligible risk to dissolved oxygen. No risk to ammonia.
Afon Aled (Reach 2) – downstream of Afon Deunant	
River Flows in the River Aled *Minor beneficial impacts during the period from February to March inclusive*	• Continued regulation releases to support downstream abstractions during low flow periods would increase flows in Reach 2
Geomorphology *Negligible impacts during the period from February to March inclusive*	• Due to the minor beneficial hydrological impact of the reach, geomorphological variation due to the drought permit is not expected to go beyond the normal low flow drought regime.
Water Quality in the Afon Aled *Negligible risk during the period from February to March inclusive*	• Negligible risk to dissolved oxygen. No risk to ammonia.
Afon Aled (Reach 3) – downstream of Bryn Aled	
Flows in the River Aled *Minor impacts during the period from February to March inclusive*	• Continued abstraction from Bryn Aled intake could reduce median (Q_{50}) flows by up to 25.4% in February to March, relative to the baseline scenario in which no abstraction is permitted

	after 3 February.
Geomorphology *Minor impacts during the period from February to March inclusive*	• Due to the moderate hydrological impact of the reach, geomorphological variation due to the drought permit is expected to be minor. The system is adapted to bedload calibre sediment, with little suspended sediment transported during drought conditions. Siltation is, therefore, unlikely and will be removed when high flows return. Further, due to the large bedload substrate and dominant rippled flow, during the implementation of the drought permit increased siltation is unlikely. Wetted widths and depths will be affected where bank slope are shallower.
Water Quality in the Afon Aled *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Unnamed Stream (Reach 4) – downstream of Dolwen Reservoir	
Flows in the unnamed watercourse *No impacts*	• Flows between Dolwen Reservoir and Plas Uchaf Reservoir, from natural inflows, would continue in both the baseline scenario in which no abstraction from Plas Uchaf Reservoir is taking place, and the drought permit scenario.
Unnamed Stream (Reach 5) – downstream of Plas Uchaf Reservoir	
Flows in the unnamed watercourse *No impacts*	• Any additional inflow from Dolwen Reservoir under the drought permit (relative to baseline scenario) would be required for abstraction to support demands at Glascoed WTW, so there would be no increase to flows downstream of Plas Uchaf Reservoir.

4.3.1 Support to the Screening and Assessment of Sensitive Features

The assessment included in **Appendix B** has provided information to support the screening and assessment of sensitive features in Section 5. This includes information on short and long term (acute and chronic) direct and indirect, cumulative, and permanent and temporary effects. The assessment is also specific on the difference between the drought permit impacts and the baseline condition without a drought permit in place.

4.3.2 Supporting Technical Information for Assessment of any Physical Environment Sensitive Features

As described in Section 5, several sensitive features relate to the physical environment, rather than ecology or human interaction (e.g. landscape, recreation). The assessment included in **Appendix B** has provided supporting technical information for their screening and assessment in Section 5.

5 AFON ALED RESERVOIR DROUGHT PERMIT ENVIRONMENTAL FEATURES ASSESSMENT

5.1 INTRODUCTION

As set out in **Box 1** above, environmental sensitivity screening of the drought permit was undertaken in line with the approach recommended by the DPG, and scoping undertaken in line with the methodology described in Section 3.2. The screening and scoping has subsequently been reviewed and refined further to discussions and consultation with NRW (see Sections 1.2 and 1.3). The outcome of this process is described in Section 5.2 which shows that a number of features were identified as either: 1) uncertain; 2) moderate-major sensitivity; or 3) minor sensitivity in a designated site. These features form the scope of environmental assessment, which is further described in Section 5.3.

The features assessment is informed by the assessment of the physical environment presented in Section 4 (which includes hydrology, geomorphology and water quality) and identifies the significance of any potential impacts. Consideration of mitigation actions and monitoring is described in Sections 6 and 10 respectively.

Points of interest referred to throughout the text in Section 5 are indicated on **Figure 2.3**.

5.2 SUMMARY OF STAGE 2 SCREENING AND SCOPING

5.2.1 Designated Sites and Other Sensitive Fauna and Flora

In accordance with the DPG, **Table 5.1** identifies designated biodiversity sites (including LNR, NNR, SSSI, SAC, SPA), Environment (Wales) Act Section 7 species / habitats and other sensitive receptors that could be affected by the drought permit. Susceptibility to the flow / level impacts resulting from the drought permit (see Section 4) is identified according to whether interest features of the site or the species are water dependent. Sensitivity is then determined according to professional judgment based on susceptibility and the level of hydrological impact at the location.

Table 5.1 Designated Sites and Other Sensitive Receptors Within the Zone of Influence of the Afon Aled Drought Permit

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs				
Mynydd Hiraethog SSSI	Minor (Llyn Aled and Aled Isaf)	Designated for sub-montane heather landscapes containing *Calluna vulgaris;* the area is one of the two largest areas of blanket peat bog in the Clwyd county. The SSSI supports extensive areas of soligenous mires with a range of mesotrophic flora including *Carex paniculata*. The area is host to a diverse upland breeding bird population, predominantly the golden plover, other species of note include; Dunlin, snipe, curlew, lapwing and sandpiper. Red Grouse, peregrine falcon, kestrel, buzzard, merlin, hen harrier, the short eared owl and black headed gulls are amongst the diverse bird population in the area.	Negligible	No
Coed Nanty Merddyn uchaf SSSI	Minor (Aled Isaf)	A mixed deciduous woodland, also representing one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions.	Negligible	No
Notable Species – Fish Brown trout *Salmo salar*	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs)	The major hydrological impact in all four reservoirs will include reduced water levels and reduced water quality. This will likely reduce the habitat available to brown trout as well as impairing connectivity to upstream tributaries for spawning.	Major	Yes (Dolwen and Plas Uchaf Reservoirs only)
Benthic macoinvertebrate community	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs)	The major hydrological impact in all four reservoirs is anticipated to alter the macroinvertebrates community composition through loss of habitat and increased competition and predation.	Moderate	Yes (Dolwen and Plas Uchaf Reservoirs only)
Phytoplankton community	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs	Increases in temperature and nutrients released from sediment as the water volume in the reservoir levels decrease could impact the phytoplankton community. This could potentially include both an increase in phytoplankton density and potentially the triggering of blue-green algal blooms.	Moderate	Yes (Dolwen and Plas Uchaf Reservoirs only)
Invasive non-native species	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs	There are no records of invasive non-native species in the four reservoirs. The risk of spreading invasive species as a result of reduced water levels through implementation of this drought permit are negligible.	Negligible	No
Archaeology	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs	No Scheduled Ancient Monuments were found around the four reservoirs.	Negligible	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Landscape and visual amenity	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs	The four reservoirs are located in the Conwy Uplands Cultural landscape area, with Llyn Aled and Aled Isaf being located in the Mynydd Hiraethog Cultural landscape area. The implementation of this drought permit will result in the lowering of reservoir levels at a faster rate and to lower levels than without the drought permit present. This may increase shoreline exposure, directly affecting landscape and visual amenity value. This will only be temporary and will be ameliorated once the drought has passed.	Negligible	No
Recreation	Minor (Llyn Aled, Aled Isaf) Major (Dolwen and Plas Uchaf Reservoirs	Plas Uchaf and Dolwen Reservoirs are managed fisheries for rainbow trout and brown trout. Llyn Aled and Aled Isaf are both managed coarse fisheries and also support a range of water sports, including sailing, water-skiing and sub-aqua diving. The major hydrological impacts in these reservoirs will result in reduced water levels which may directly impact the fish communities of the reservoirs as well as increase shoreline exposure, and impact recreational access. Lake drawdown and shoreline exposure in times of drought will be temporary in nature.	Uncertain	Yes (Dolwen and Plas Uchaf Reservoirs only)
Afon Aled – River Reaches 1, 2, 3, 4 and 5				
Coed Nanty Merddyn uchaf SSSI	Minor beneficial (Reach 1)	A mixed deciduous woodland, also representing one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions.	Negligible	No
Coed Llys Aled SSSI	Minor beneficial (Reach 2)	Designated due to high botanical importance. The woods represent one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions.	Negligible	No
Environment (Wales) Act Section Species - Fish Atlantic salmon *Salmo salar* European eel *Anguilla anguilla* Bullhead *Cottus gobio* Brown and sea trout *Salmo trutta* Lamprey species	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	Reduction in flow is can reduce the availability of habitat for fish, and increase the risk of predation. Flow and level impacts could also influence spawning and migration of Section 7 fish species as well as increasing mortality.	Minor	No
Notable Species – Mammal European Otter *Lutra lutra*	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	Otter has been recorded in the lower reaches of the Afon Aled. This species is not expected to be significantly impacted by drought permit implementation as habitat availability and quality is not anticipated to be significantly altered. The reduction in river level may even be beneficial to otter with prey more easily accessible	Negligible	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Fish community Minnow *Phoxinus phoxinus*, Stoneloach *Barbatula barbatula*	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3))	A number of other fish species occur within the Afon Aled. Reduction in flow could increase mortality and reduce recruitment due to habitat loss.	Minor	No
Benthic macoinvertebrate community	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	The macroinvertebrate community is likely to be sensitive to changes in flow as a result of the drought permit.	Minor	No
Phytobenthos community	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	The phytobenthos community is likely to be sensitive to changes in flow as a result of the drought permit.	Minor	No
Invasive non-native species - Freshwater shrimp *Crangonyx pseudogracilis*	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	The freshwater shrimp is the only invasive non-native species known to be present in these river reaches based on available data. The risk of spreading invasive species through implementation of this drought permit are negligible as reductions in flow are within natural ranges.	Negligible	No
Archaeology	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	No Scheduled Ancient Monuments were found around Reach 3 of the Afon Aled.	Negligible	No
Landscape and visual amenity	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	The hydrological impacts in Reach 3 will not result in lowering of river levels below the natural range. As such landscape and visual amenity of the reach will not be adversely affected.	Negligible	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Recreation	Minor (Reach 3 – February - March) Minor Beneficial (Reaches 2 and 3)	The hydrological impacts in Reach 3 will not result in lowering of river levels below the natural range. As such recreation activities in the reach will not be adversely affected. Impacts on the fish population of the reach are possible, it is uncertain the extent to which this will impact recreational fishing activities.	Negligible	No

5.2.2 WFD Waterbody Status

Table 5.2 identifies the WFD status classification of the WFD waterbodies that may be impacted by implementation of the drought permit. Waterbodies classified as overall high / good status / potential, and / or high / good ecological status for fish or macroinvertebrates are likely to be more sensitive to flow impacts. **Table 5.2** summarises the risk to WFD status and indicates where further assessment has been carried out as reported in Section 5.3 below.

Table 5.2 WFD Status Classifications

Waterbody Name	**GB110066059770 (Aled - Elwy to Deunant)**		**GB31033261 (Plas Uchaf and Dolwen Reservoirs)**	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Moderate		Major	
Heavily Modified Waterbody (Y/N)	Yes		Yes	
RBMP Cycle	RBMP2 (2015)[7]	2018 C2 Interim[8]	RBMP2 (2015)	2018 C2 Interim
Overall Ecological	Good	Good	Moderate	Moderate
Fish	High	High	Not assessed	Not assessed
Macrophytes and Phytobenthos	Not assessed	Not assessed	Not assessed	Not assessed
Phytobenthos (Sub-Element)	Not assessed	Not assessed	Not assessed	Not assessed
Macrophyte (Sub-Element)	Not assessed	Not assessed	Not assessed	Not assessed
Phytoplankton	N/A	N/A	Moderate	Moderate
Macro-invertebrates	High	High	Not assessed	Not assessed
Total P/ Phosphate	High	High	Moderate	Poor
Ammonia	High	High	Not assessed	Not assessed
Dissolved Oxygen	High	High	Not assessed	Not assessed
pH	High	High	Not assessed	Not assessed
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Moderate		Major	
Further Consideration Required (Y/N)	Yes		Yes	

[7] NRW (2017) https://drive.google.com/file/d/0B2hsDbbdxz1tZHItRU9lNkg1YWs/view
[8] NRW (2018) https://drive.google.com/file/d/14w17jL05sNuToVELqMCK_yc6DdHU7STb/view

5.3 FEATURES ASSESSMENT

5.3.1 Basis of Features Assessment

This section describes and assesses the potential impacts on the sensitive features during the period of implementation of the drought permit.

Based on the sensitive features identified in Section 5.2.2, the degree of impact has been assessed and analysed in Section 5.3. Desk-based assessments have been completed for each of the sensitive receptors, where applicable, in order to determine the magnitude of impact in the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit hydrological zone of impact. Each feature assessment describes the analyses carried out and a statement of the assessed impact. All impacts are considered to be negative / adverse unless otherwise stated in the feature assessment. The approach is described in Section 3.3.

The hydrological assessment is summarised in Section 4 and is presented in full in **Appendix B**.

5.3.2 Summary of Features Assessment

Table 5.3 presents the overall summary of the significance of potential impacts of the drought permit identified from the assessment of designated sites, and other ecologically significant receptors and their relevant reaches. Full details of the features assessment are provided in **Appendix D**. A brief summary of the features assessment is also provided below in Sections 5.3.3 – 5.3.8.

Table 5.3 Summary of Impacts of Drought Permit Implementation Pre-Mitigation

Month		J	F	M	A	M	J	J	A	S	O	N	D
Dolwen Reservoir Plas Uchaf													
Macrophytes					N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Macroinvertebrates					N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Brown trout	Connectivity				N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Habitat loss				N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Water quality				N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Phytoplankton		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N
Recreation		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Landscape		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N

Key to Environmental Effects:

N	Negligible impacts are considered likely
N/A	Outside implementation period
	Minor adverse impacts are considered likely
	Moderate adverse impacts are considered likely
	Major adverse impacts are considered likely
	Potential minor beneficial impacts are considered likely
	Potential moderate beneficial impacts are considered likely

5.3.3 WFD and Community Assessment

This section considers the potential impact on the feature community within each reach as well as identifying the risk of deterioration in status / potential under the WFD.

WFD Definitions

The following definitions are provided for the determination of status under the WFD.

High ecological status - the values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions and show no, or only very minor, evidence of distortion.

Good ecological status - the values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

Moderate ecological status - the values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Poor ecological status - waters showing evidence of major alterations to the values of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.

Bad ecological status - waters showing evidence of severe alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type are absent, shall be classified as bad.

Good ecological potential - there are slight changes in the values of the relevant biological quality elements as compared to the values found at high ecological potential.

Moderate ecological potential - there are moderate changes in the values of the relevant biological quality elements as compared to the values found at maximum ecological potential.

The Environment Agency[9] identify that a number of different factors need be considered when making an assessment of the ecological potential of HMWBs. Of primary importance is the need to put a specified range of mitigation measures in place to address the effects of the anthropogenic impact. Selected ecological quality elements may also be required to be at GES for the waterbody to be classified as GEP. Where the designated use includes for impacts on flow and flow-related mitigation measures the measured status of the fish and macroinvertebrate communities do not affect the classification of GEP.

Assessment

A summary of the potential impacts of the drought permit on macrophyte, macroinvertebrate, phytobenthos, phytoplankton and fish communities and WFD status is presented below. Full details, including detailed baseline information, can be found in **Appendix D**.

Macrophytes

Table 5.5 presents a summary of the potential impacts of the drought permit identified from the assessment of macrophytes.

Table 5.5 Summary of Impacts of Drought Permit Implementation on Macrophytes

WFD Status/ Community	Impact	Significance of Impact
GB31033261 (Plas Uchaf and Dolwen Reservoirs) Current status- Not assessed	• Not assessed	**N/A**
Feature	**Impact**	**Significance of Impact**
Dolwen Reservoir and Plas Uchaf		
Macrophytes	• Desiccation or reduced habitat suitability due to reduced water level, including exposure of wintergreen plants or vegetative dispersal mechanisms (turions) • Reduced habitat suitability for submerged macrophyte species which require deep water • Encroachment of terrestrial or marginal vegetation into areas of shoreline exposed by reduced water levels.	**Moderate (uncertain)**

[9] Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011

Macroinvertebrates

Table 5.6 presents a summary of the potential impacts of the drought permit identified from the assessment of macroinvertebrates.

Table 5.6 Summary of Impacts of Drought Permit Implementation on Macroinvertebrates

WFD Status/ Community	Impact	Significance of Impact
GB31033261 (Plas Uchaf and Dolwen Reservoirs) Current status- Not assessed	• Not assessed	**N/A**
Dolwen and Plas Uchaf		
Feature	**Impact**	**Significance of Impact**
Macroinvertebrates	• Loss of the littoral zone resulting in potential desiccation and loss of habitat. • Increased competition and predation rates. • Reduction in diversity.	**Moderate**

Fish

Table 5.7 presents a summary of the potential impacts of the drought permit identified from the assessment of fish.

Table 5.7 Summary of Impacts of Drought Permit Implementation on Fish

WFD Status/ Community	Impact	Significance of Impact
GB31033261 (Plas Uchaf and Dolwen Reservoirs) Current status- Not assessed	• Not assessed	**N/A**
Feature	**Impact**	**Significance of Impact**
Dolwen and Plas Uchaf Reservoirs)		
Brown trout	• Reduced connectivity with spawning tributaries	**Minor adverse**
	• Reduction in juvenile survival due to habitat loss.	**Moderate adverse**
	• Reduced water quality	**Moderate adverse**

Phytoplankton

Table 5.8 presents a summary of the potential impacts of the drought permit identified from the assessment of macroinvertebrates.

Table 5.8 Summary of Impacts of Drought Permit Implementation on Phytoplankton

WFD Status/ Community	Impact	Significance of Impact
Dolwen Reservoir and Plas Uchaf		
Phytoplankton	• Increases in temperature and nutrients released from sediment as the water volume decreases • Increase in phytoplankton density and potentially the triggering of blue-green algal blooms	**Negligible**

5.3.4 Landscape and Recreation

Table 5.10 presents a summary of the potential impacts of the drought permit identified from the assessment of landscape and recreation.

Table 5.10 Summary of Impacts of Drought Permit Implementation on Landscape and Recreation

Feature	Impact	Significance of Impact
Plas Uchaf and Dolwen Reservoirs		
Landscape	• Reduction in the water levels would affect the visual amenity of the landscape, however water levels would also be reduced	**Negligible**
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**

6 AFON ALED DROUGHT PERMIT– MITIGATION

The environmental assessment has identified some significant impacts, including moderate hydrological impacts, moderate aquatic ecology impacts on fish, macroinvertebrates and macrophytes.

For those receptors with a potential impact or risk identified as being significant as a result of implementation of the drought permit, precautionary monitoring and mitigation measures have been identified, and will be further developed in consultation with NRW.

Mitigation measures are feature, location, species and community specific, and are targeted only to those impacts that arise specifically as a result of drought permit implementation (as opposed to those arising due to environmental drought pressures). Similarly, monitoring and the targeting of mitigation measures to impacts that arise specifically as a result of drought permit implementation will help identify the responsible party for the specific actions relating to the associated measure. Information attained through monitoring undertaken during future droughts and potential drought permit implementation events will provide a tool for discussions regarding best working practices between Welsh Water, NRW and any other interested parties.

The range of mitigation measures that are possible for the features identified fall into three general activity types:

1) measures to reduce impacts at source

2) measures to modify environmental conditions in the river/lake

3) management of sensitive ecological species and communities.

The first activity type looks at mitigation measures that will reduce the pressure at source by reducing the hydrological impact. In the circumstances, the options are limited because the drought permit is required to safeguard public water supply. The second activity focuses on mitigation measures that involve undertaking actions within the waterbodies to reduce the pressure at sensitive locations. The third activity type involves direct action to manage impact by movement or management of the receptor / feature itself.

The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:

6.1 Potential Generic Mitigation Measures Considered to Address Adverse Effects of the Drought Permit

Type of Mitigation	Typical Application
Temporary reduction or cessation of the terms of the Drought Order/Permit	Where continuous water quality monitoring (typically dissolved oxygen) and/or fish distress monitoring indicate a sharp deterioration in aquatic conditions, modifications to abstraction licence conditions under the terms of the order/permit may need to be reduced or cease altogether until conditions have improved. The precise trigger levels for considering such action would be set out in discussion with NRW at the time of application taking account of the time of year and prevailing environmental conditions. Temporary cessation of the implementation of the order/permit may be required as a means of mitigating ecological effect, balanced against the need to safeguard public water supplies.
Fish distress monitoring with triggers and response plan	Regular visual observations carried out on key stretches of rivers or lakes to detect signs of large scale fish distress and agree appropriate mitigation with NRW specific to the conditions identified. This might include temporary oxygenation measures.
Protection of 'spate flows'	Temporary increases in river flows following periods of rain can be important to flush sediment/pollutants from the system or promote fish passage. Where possible, the terms of the drought order/permit could be temporarily reduced/suspended so that these spate flows are preferentially allowed to pass through the system. This decision would need to be taken in dialogue with NRW to take account of the prevailing conditions and considering the merits of encouraging fish migration during a drought.
Reduce fish predation	Consider (where feasible) a limited and targeted reduction of predation risk on fish through either the provision of refugia, in the form of artificial or natural habitat provision or improvement, or the placement of piscivorous bird scarers (in areas remote from residential locations). The merits of each option and subsequent deployment would be subject to review on a case-by-case basis in consultation with NRW.
Physical works	In some cases, temporary physical in-river works such as channel narrowing or provision of refugia could be carried out to mitigate environmental risks. If any physical works are likely to impact fish passage, appropriate mitigation measures will need to be considered as part of the design of the works.
Compensation flows	In some cases, it may be possible to use other sources of water to provide compensation flows within surface water courses to temporarily mitigate the impact of the drought order/permit
Provision of alternative water supplies	If there is a risk of derogation of other abstractors from the drought order/permit, it may be possible for Welsh Water to provide alternative water supplies or lower pumps in boreholes. Provision is otherwise provided in legislation[10] for compensation to be agreed with the abstractor.

A suggested suite of mitigation measures for environmental features with potentially significant impacts relating to implementation of the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit are given in **Table 9.1**. For these features, a range of precautionary monitoring and triggers leading to enabling of appropriate mitigation measures are also described.

[10] Schedule 9 of the Water Resources Act (WRA) 1991

7 CUMULATIVE IMPACTS

In accordance with the DPG and the Habitats Regulations, consideration has been given to how the proposed drought permit may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction licences and discharge permits, as identified in NRW Review of Consents reports;
- Assessment of cumulative impacts of the drought permit with other Welsh Water supply-side and drought permit options within the hydrological zone of influence (including both intra- and inter- zone options);
- Other plans and projects of relevance, including;
    - Any Welsh Water WRMP schemes which are scheduled to be implemented and become operational within the time period of the Drought Plan (i.e. before 2025).
    - Drought supply-side and drought permit / permit options from NRW Drought Plans.
    - National Policy Statements for Wastewater and Renewable Energy Infrastructure.
- Environmental monitoring before, during and after drought permit implementation (see Section 9).

If a drought permit application is progressed in the future, the potential for cumulative effects will be reviewed and revised to reflect any changes which are relevant to the timing of the drought permit specified in the application.

Welsh Water's existing abstraction licences and other abstraction licences and discharge permits

The assessment of hydrological impacts presented in **Appendix B**, and summarised in Section 4, has considered how the proposed drought permit may affect the environment in combination with the effects of existing licences and consents. Therefore no relevant licences or consents have been identified as relevant for assessment of cumulative effects.

Other relevant Welsh Water drought permit / orders

No cumulative effects of implementing the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit with drought order / permit schemes have been identified.

However, this should be reviewed at the time of any future application for a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs.

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

NRW Drought Plans

No cumulative impacts of options in NRW Drought Plan with a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs are anticipated. However, this should be reviewed at time of future application for a drought permit.

National Policy Statements for Wastewater and Renewable Energy Infrastructure

No cumulative schemes have been identified for assessment.

Environmental Monitoring

Recommendations for environmental monitoring before, during and after drought permit implementation have been made in the EMP which is presented in Section 9 of this EAR. The EMP has been developed in consultation with NRW.

It is assumed that all monitoring activities will be undertaken with the best interests of the site in mind, and in discussion and agreement with NRW. Where activities which require in-river working are proposed, a method statement for the survey will be prepared and agreed with NRW in advance of the survey.

Assuming rigorous implementation of the method statements, there will be no adverse impacts of the monitoring on hydrology, water quality or ecology, and no adverse impacts of environmental monitoring on the site are anticipated.

8 AFON ALED DROUGHT PERMIT - SUMMARY OF RESIDUAL IMPACTS

The residual impact on environmental features is dependent on the effects observed during environmental monitoring, and the mitigation measures that are taken forward and their timely and effective application once the trigger for their need has been identified. Consequently, at this stage it is not possible to provide an accurate indication as to the residual impacts on environmental features due to implementation of mitigation measures. However, should the mitigation measures be effectively applied in all situations in a timely manner, it is anticipated that the magnitude of impacts, and in some cases the significance of impacts, will be reduced from those summarised in **Table 5.3**.

Should the application of mitigation measures applicable during the drought permit implementation period not reduce the impact magnitude or significance, compensatory measures such as restocking will be considered to help ensure pre-drought conditions return and reduce the significance of any post-drought permit impacts.

9 ENVIRONMENTAL MONITORING PLAN (EMP)

9.1 INTRODUCTION

The overall scope of the EMP for the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit meets the requirements of Section 5.2 (Monitoring) and informs the requirements of Section 5.3 (Mitigation) of the DPG. As required by the DPG, the level of monitoring identified in the EMP is risk-based. The EMP is tailored to the characteristics of the study area and is informed by the knowledge and assessment of environmental sensitivity (presented in Sections 4 and 5 of this EAR). The EMP fulfils several requirements, including:

- Establishing required baseline environmental monitoring and data acquisition to maintain and update the understanding of the environmental baseline conditions and to reduce uncertainties in the assessment.
- Pre-drought permit monitoring describes the prevailing environmental conditions prior to drought permit implementation. This will inform the implementation and management of any mitigation actions during the drought.
- During-drought permit monitoring describes the environmental conditions during the implementation of the drought permit. Surveillance monitoring of sensitive locations, informed by, for example, walkover surveys and pre-drought monitoring, will provide early warnings of any unpredicted environmental impacts and ensure that mitigation actions are operating as designed.
- Post-drought permit monitoring describes the recovery of environmental conditions following the cessation of a drought permit, and establishes whether the affected ecosystems have recovered to conditions prevailing in the pre-drought permit period.

The basis of the development of the EMP is provided in 9.2 Monitoring recommendations are set out in Section 9.3.

9.2 BASIS OF THE EMP

Guidance on the objectives and content of the EMP is given in Section 5.2 and Appendix J of the DPG.

The guidance states that:

- Water companies are responsible for understanding the effects of a drought and its drought management actions on the environment and that companies can demonstrate this by assessing the impacts of drought management actions during and after a drought and completing the environment assessment.
- Companies should ensure that adequate arrangements for environmental

monitoring are detailed in an EMP within its drought plan.

- The level of monitoring needed should be risk-based. Not all sites will require in-drought and post-drought monitoring.
- Surveys may be needed to support/inform the decisions on environmental sensitivity and likely impact or to ascertain baseline conditions.
- In-drought permit monitoring is required to assess the impacts from the implementation of the drought management action and for the management of mitigation actions during a drought.
- Post-drought permit monitoring aims to assess a site's recovery.
- Sites with moderate to major environmental risk should focus monitoring on those feature(s) sensitive to the likely impacts from implementing drought management actions. For Habitats Directive sites, data collected will be sufficient to demonstrate there is no adverse effect on the interest features. For SSSIs, data collected will need to be sensitive enough to pick up the likelihood of damage at the site. For WFD sites data collected will be to assess any potential 'deterioration' to status and allow you to comply with the requirements of Articles 4.6 to 4.9.
- Control sites are important to provide a comparison between the 'natural' impacts of the drought and the impacts of the drought management action.
- The EMP should include details of any surveys to support the environmental assessment, in-drought and post-drought data needs, including:
    - the feature/s to be monitored and the methods used
    - the location of survey sites
    - the timing and frequency of monitoring
    - who will undertake the monitoring.
- Separating the 'natural' impacts of a drought from those resulting from the implementation of drought management actions can be complex and made more difficult where data problems and/or a lack of hydro-ecological understanding exists. Water companies must ensure that their EMP is adequate to assess the most significant environmental impacts of its proposed drought actions and associated mitigation measures.
- The EMP needs to be agreed with NRW. Consultation with NRW should be undertaken to ensure that the monitoring proposed within the EMP to assess the potential impacts at these sites is adequate.
- A water company must provide details in the Drought Plan of likely mitigation or compensation needed against serious impacts on the environment or other water users of any proposed drought action. The EMP should assist in identifying sites that may require mitigation. In some cases, mitigation actions may be necessary to prevent derogation of other abstractions (for example, by providing alternative

supplies or releasing compensation water into watercourses to limit the impact of reduced flows).

9.3 MONITORING RECOMMENDATIONS

The EMP describes the nature and extent of the baseline and drought year data that would be required in order to differentiate the impacts resulting solely from the implementation of a drought permit with those resulting naturally as a result of the drought itself. The EMP is site specific and the scope is based on the current assessment of the drought permit.

Recommendations for pre-drought, in drought and post-drought monitoring, based on the outcome of the current environmental assessment, are provided in **Table 9.1.** and are illustrated on **Figure 9.1**.

Monitoring outside of drought conditions is also recommended to address the baseline data limitations to the environmental assessment identified in this report and ensure a robust baseline exists for all sensitive features.

Data and results from baseline monitoring will increase the robustness of the assessment, and will be incorporated at the time of EAR preparation to support any future application for drought powers. The impact assessment has adopted a precautionary approach where baseline data limitations have been identified.

Control sites are crucial in assessing the ecological impact of flow pressure resulting from water resource activities. They can help determine whether any ecological impact being observed is a result of the water resource activity being investigated, rather than wider environmental influences. Good control sites for hydroecological assessment should be chosen where there are no significant water quality problems or pressures which could undermine relationships between ecology and flow. They must not be affected by the water resource activity being investigated nor have additional water resource activity upstream that could affect the flow regime. It is imperative that they are as similar in nature to the baseline conditions of the impact sites as possible, most importantly stream size and channel gradient. Possible options could include reaches upstream of those impacted, or other watercourses where the watercourses are comparable and not subject to a drought permit/order application. Control sites will need to be identified at the time of application following a review of where drought permit/orders are required to be implemented. Consultation with NRW to determine suitable control sites will be undertaken at the time of application of this drought permit.

The following monitoring programme is an initial draft and will be iterated and agreed with NRW prior to EMP implementation. Any updates to the EMP will consider:

- Any potential changes in the assessment of the hydrological, water quality and

geomorphological impacts based on baseline conditions at the onset of drought;

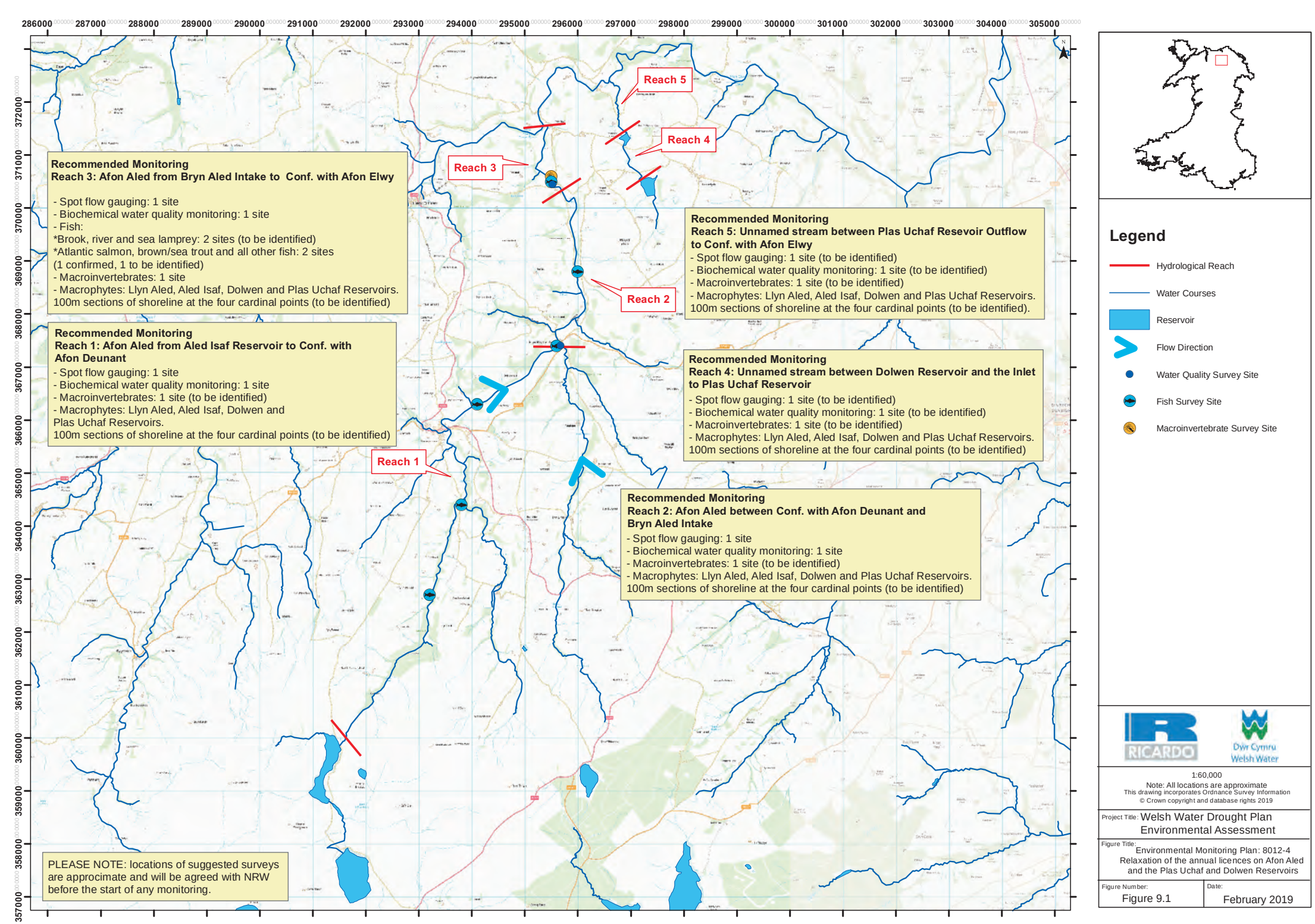
- Any potential changes in the assessment of impacts on environmental features based on baseline conditions at the onset of drought; and
- Any changes in assessment and/or monitoring methodologies and biological indices.

Table 9.1 Baseline, Pre, Onset, During and Post Drought Monitoring and Mitigation Recommendations

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	**Monitoring and trigger setting**	**Trigger and monitoring to inform mitigation action**	**Mitigation actions triggered by monitoring**	**Monitoring and post-drought mitigation (where applicable)**	
		Spot flow gauging surveys	One site per hydrological reach. Three occasions.	One site per hydrological reach. Three occasions.	N/A	One site per hydrological reach. Three occasions.	Welsh Water
		Biochemical water quality sampling.	One site per hydrological reach. Monthly. Consider continuous monitoring.	One site per hydrological reach. Weekly. Consider continuous monitoring.	N/A	One site per hydrological reach. Monthly, until recovery to pre-drought levels. Consider continuous monitoring.	Welsh Water
Macrophyte **Plas Uchaf and Dolwen Reservoir**	Desiccation or reduced habitat suitability due to reduced water level, including exposure of wintergreen plants or vegetative dispersal mechanisms (turions) Reduced habitat suitability for submerged macrophyte species which require deep water Encroachment of terrestrial or marginal vegetation into areas of shoreline exposed by reduced water levels.	No baseline macrophyte monitoring information was available for Dolwen or Plas Uchaf. Lake macrophyte survey according to the JNCC CSM for Lakes methodology is recommended. Four shoreline transects, shoreline and wader survey at each and boat transect to maximum depth of colonisation at each. Surveys should be undertaken between June – mid September. Notes should be made of locations of any rare species encountered and extent and locations of populations investigated further by targeted non-destructive (i.e. non grapnel) survey of favourable habitats. If any protected species found then snorkel survey recommended to locate and map populations.	Lake macrophyte survey according to the JNCC CSM for Lakes methodology is recommended to understand baseline community at the onset of drought as reservoirs levels will already be low. Four shoreline transects, shoreline and wader survey at each and boat transect to maximum depth of colonisation at each. Walkover survey to identify any signs of algal blooms.	Walkover survey to identify any signs of algal blooms. Lake macrophyte survey according to the JNCC CSM for Lakes methodology is recommended. Four shoreline transects, shoreline and wader survey at each and boat transect to maximum depth of colonisation at each. Walkover survey to identify any signs of algal blooms.	Mitigating impacts to the macrophyte community as a result of lowered water level is not feasible during drought permit implementation. Mitigating this impact should be triggered by post drought macrophyte community assessments to implement post drought mitigation measures.	In the two years following drought permit/order implementation and in June to September monitoring period carry out lake macrophyte survey according to the JNCC CSM for Lakes methodology. To be extended if recovery has not occurred in two years. Significant alteration to macrophyte community composition (as informed by expert judgement, based on baseline data) triggers post drought mitigation actions: If existing macrophyte community has significantly deteriorated, consider reseeding /replanting where possible to promote recovery. Replanting of macrophyte community composition to be informed by pre-drought community.	Welsh Water
Macroinvertebrates **Llyn Aled, Plas**	Loss of the littoral zone resulting in	No baseline macroinvertebrate monitoring data was available for Dolwen or Plas Uchaf.	Seasonal monitoring of macroinvertebrates at the	Seasonal monitoring of macroinvertebrates at	Mitigating impacts to the macroinvertebrate community as a result of	In the two years following drought permit implementation, of kick	Welsh Water

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
Plas Uchaf and Dolwen Reservoir	potential desiccation and loss of habitat Increased competition and predation rates. Reduction in diversity	Kick sampling for benthic invertebrates should be undertaken at 5 locations with each reservoir and identified to species level for implementation of the Chironomid Pupal Exuviae Technique (CPET) index.	baseline survey sites (summer and autumn). Samples to be collected and identified to species level for implementation of the Chironomid Pupal Exuviae Technique (CPET) index. Carry out water quality surveys at same time. In severe drought conditions, no monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	the baseline survey sites (summer and autumn). Samples to be collected and identified to species level for implementation of the Chironomid Pupal Exuviae Technique (CPET) index. Carry out water quality surveys at same time. In severe drought conditions, no in stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	lowered water level is not feasible during drought permit implementation. .	sampling for benthic invertebrates baseline sites. Samples identified to species level for implementation of the Chironomid Pupal Exuviae Technique (CPET) index. To be extended if recovery has not occurred in two years. Mitigating impacts to the macroinvertebrate community as a result of lowered water level is not feasible.	
Fish (brown trout) **Plas Uchaf and Dolwen Reservoir**	Reduced water quality Reduced connectivity with spawning tributaries Increase in mortality due to habitat loss.	Fish populations from the reservoirs are not well understood. Baseline surveys are required for each reservoir. Fyke net survey (minimum of one survey during summer months) and analysis of angler catch and stocking data.	Fyke net survey and analysis of angler catch and stocking data. In severe drought conditions, no fish population surveys are advised during drought as this may cause further stress. Walkover of key sections known to be susceptible to lower flows: • Identification of key habitats which are at risk of fragmentation. Approximation of the number of each fish species (e.g. 10s, 100s) in each ponded reach, where safe and practical to do so.	No fish population surveys are advised during drought as this may cause further stress. Additional walkovers, if situation is expected to deteriorate - Record extent of exposed marginal habitats, spawning habitats, bed substrates. Frequency of walkovers to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of	If water quality risks identified, deployment of aeration equipment in lakes. Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover surveys. Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW.	Two years of annual post-drought fish population surveys at baseline monitoring sites to determine any changes in population dynamics both temporally and spatially. The results of the fish population surveys should help inform mitigation targeting habitat restoration where deemed to be appropriate to support and enhance affected populations. Fish stocking to be undertaken if losses/impact to angling occurs	Welsh Water

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
			Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment. Appropriate trigger values would be set for level and flow for spawning habitats based on local circumstances, timing, seasonality and expert opinion.	the drought. Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment. Deployment of automated water quality equipment that continuously monitors for dissolved oxygen.	In extreme cases (where environmental parameters such as dissolved oxygen and temperature allow), consider removal of concentrated abundances of fish deemed to be stranded/at risk, relocating fish to suitable locations outside of the impacted reach within more suitable catchment, but would need to be discussed with NRW to ensure compliance with the Keeping and Introduction of Fish Regulations 2014.		


Reach 5
Reach 4
Reach 3
Reach 2
Reach 1
Recommended Monitoring
Reach 3: Afon Aled from Bryn Aled Intake to Conf. with Afon Elwy
- Spot flow gauging: 1 site
- Biochemical water quality monitoring: 1 site
- Fish:
*Brook, river and sea lamprey: 2 sites (to be identified)
*Atlantic salmon, brown/sea trout and all other fish: 2 sites (1 confirmed, 1 to be identified)
- Macroinvertebrates: 1 site
- Macrophytes: Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs. 100m sections of shoreline at the four cardinal points (to be identified)
Recommended Monitoring
Reach 5: Unnamed stream between Plas Uchaf Resevoir Outflow to Conf. with Afon Elwy
- Spot flow gauging: 1 site (to be identified)
- Biochemical water quality monitoring: 1 site (to be identified)
- Macroinvertebrates: 1 site (to be identified)
- Macrophytes: Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs. 100m sections of shoreline at the four cardinal points (to be identified).
Recommended Monitoring
Reach 1: Afon Aled from Aled Isaf Reservoir to Conf. with Afon Deunant
- Spot flow gauging: 1 site
- Biochemical water quality monitoring: 1 site
- Macroinvertebrates: 1 site (to be identified)
- Macrophytes: Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs. 100m sections of shoreline at the four cardinal points (to be identified)
Recommended Monitoring
Reach 4: Unnamed stream between Dolwen Reservoir and the Inlet to Plas Uchaf Reservoir
- Spot flow gauging: 1 site (to be identified)
- Biochemical water quality monitoring: 1 site (to be identified)
- Macroinvertebrates: 1 site (to be identified)
- Macrophytes: Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs. 100m sections of shoreline at the four cardinal points (to be identified)
Recommended Monitoring
Reach 2: Afon Aled between Conf. with Afon Deunant and Bryn Aled Intake
- Spot flow gauging: 1 site
- Biochemical water quality monitoring: 1 site
- Macroinvertebrates: 1 site (to be identified)
- Macrophytes: Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs. 100m sections of shoreline at the four cardinal points (to be identified)
PLEASE NOTE: locations of suggested surveys are approcimate and will be agreed with NRW before the start of any monitoring.
Legend
Hydrological Reach
Water Courses
Reservoir
Flow Direction
Water Quality Survey Site
Fish Survey Site
Macroinvertebrate Survey Site
RICARDO
Dŵr Cymru Welsh Water
1:60,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
© Crown copyright and database rights 2019
Project Title: Welsh Water Drought Plan Environmental Assessment
Figure Title: Environmental Monitoring Plan: 8012-4 Relaxation of the annual licences on Afon Aled and the Plas Uchaf and Dolwen Reservoirs
Figure Number: Figure 9.1
Date: February 2019

10 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Afon Aled / Plas Uchaf and Dolwen Reservoirs drought permit. If granted and implemented, the drought permit would enable Welsh Water to continue to abstract from the Afon Aled catchment at high demands of up to the daily licensed maximum rates, to meet higher than usual demands in drought conditions.

The scope of the assessment has been defined by an impact screening and scoping exercise. In accordance with the DPG, the screening exercise involved two stages, a hydrological impact assessment (Stage 1) and the identification of the environmental features that could be affected by the drought permit (Stage 2).

The assessment has concluded that there is a **major** impact on Plas Uchaf and Dolwen Reservoirs as a result of implementing the drought permit. Impacts on the Afon Aled, Llyn Aled and Aled Isaf have been assessed as minor beneficial to minor adverse. These hydrological impacts are assessed as leading to **moderate** impacts on the physical environment of the river, including water quality.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified WFD status and Community Assessment / Environment (Wales) Act Section 7 Species, macroinvertebrates, phytoplankton, landscape and recreation as environmental features for which an environmental assessment was required.

The assessment has concluded that there are **minor to moderate** impacts on fish, macroinvertebrates, and macrophytes and **negligible** impacts on phytoplankton in the Plas Uchaf and Dolwen Reservoirs.

No cumulative effects of implementing the drought permit with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs.

The environmental assessment has identified significant impacts of implementation of a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs. Consequently, in line with the DPG, mitigation measures have been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

In summary, it has been concluded that the environmental effects on river flows and ecology of implementing a drought permit at Afon Aled / Plas Uchaf and Dolwen Reservoirs, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **moderate**.

APPENDIX A
HYDROLOGY AND HYDROGEOLOGY METHODOLOGY

A.1 HYDROLOGICAL AND HYDROGEOLOGY IMPACT METHODOLOGY (STAGE 1 SCREENING)

Consideration is required (by the DPG[1]) of the likely changes in flow / level regime due to implementing the drought management action, specifically:

- the perceived extent of potential impact
- the nature and duration of the potential impact
- the timing of the potential impact.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see Section 3.2.1 in main report) to identify the environmental risk of the drought order / permit.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix H of the DPG), it does not provide a methodology for identifying the hydrological impact.

Cascade has developed a flexible approach[2] to identifying the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts, although this is only appropriate to apply to reaches that do not dry naturally. A hydrological methodology for watercourses that naturally dry for part of the year is also presented that characterises the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts. These are presented below.

Perennially flowing watercourse hydrological methodology

This methodology is applied to watercourses that flow throughout the year and that are potentially impacted on by the drought order / permit.

Core to this approach is the use of relevant long term flow statistics to inform the scale of hydrological impact and thereby delimit the zone of influence in the downstream river system. To determine these, potential reductions in flow resulting from implementation of the drought order / permit are compared with flows without the drought order / permit in place (i.e. the additional abstraction advocated by the drought order / permit over and above the existing abstraction). This helps to determine the scale of potential impact at any particular site/ feature using the matrix in **Figure A.1** or **Figure A.2** depending on the altitude of the waterbody and whether it is classified as lowland or upland[3]. Where possible, the hydrological assessments presented in previous EMPs and EARs of the drought options have been used to

1 Welsh Government / Defra / NRW / Environment Agency (2011). Water Company Drought Plan Guideline. June 2011.
2 Hydrological impact approach used in previous drought plan environmental assessments for water companies including Thames Water, Yorkshire Water and United Utilities
3 The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.
The Directions set out the principles of classification of surface water and groundwater bodies, including the use of 80m above Ordnance Datum as the altitude that differentiates water quality requirements for upland and lowland biology. Where there are ambiguities, or thresholds are crossed, upland is assumed to apply to ensure a precautionary assessment.

help identify the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area.

Figure A.1 Hydrological Assessment Matrix (Upland)

		Summer Q99		
	% reduction in flow	<10%	10-25%	>25%
Summer Q95	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

Figure A.2 Hydrological Assessment Matrix (Lowland)

		Summer Q99		
	% reduction in flow	<10%	10-25%	>25%
Summer Q95	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

Figure A.1 illustrates that at the time of implementation of a drought order / permit, upland river systems of relevance to each of these proposed options will exhibit high sensitivity to changes in low flow (represented by Q_{95}, summer[4]) and very high sensitivity to changes in extreme low flow (represented by Q_{99}, summer). As illustrated by **Figure A.2**, lowland rivers of relevance to each of these proposed options are considered to be less sensitive to reductions in summer low flows (summer Q_{95}), but similarly sensitive to reductions in extreme summer low flows (summer Q_{99}).

Figures A.1 and **A.2** are appropriate for the assessment of hydrological impacts on low flow regimes in watercourses during the spring, summer and autumn. However, in some cases there is a need to assess the impacts of drought order schemes on watercourses during the winter. For example, a reduction in compensation release may remain in force during the winter high flow period, to increase the probability of reservoir refill prior to the following year's spring/summer drawdown period. During the winter season, watercourses have relatively lower sensitivity to changes in low flow, and moderate sensitivity to changes in moderate flow. This can be reflected by the use of the matrices in **Figures A.3** and **A.4** for the assessment of drought order / permit schemes which are only likely to impact on a watercourse during the winter. The categorisation of impacts as negligible, minor, moderate or major is based on the percentage reduction in year round low flow (Q95) and year round median flow (Q50).

Figure A.3 Hydrological Assessment Matrix (Upland / Winter)

		Year round Q95		
	% reduction in flow	<10%	10-25%	>25%
Year round Q50	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

[4] Flow statistics indicate the proportion of days a flow is equalled or exceeded. Therefore Q95 indicates flow equalled or exceeded on 95% of days in the measured record (equivalent to an average of 347 days per year)

Figure A.4 Hydrological Assessment Matrix (Lowland / Winter)

		Year round Q95		
	% reduction in flow	<10%	10-25%	>25%
Year round Q50	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

The matrices are used to identify 1) the overall study area – which extends downstream of the abstraction until the hydrological impact has reduced to negligible; 2) reaches with similar scales of impact within the overall study area; and 3) the scale of hydrological impact within each reach. Typically reaches have been delimited by the addition of flow from a significant tributary or discharge; although the similarity of geomorphological characteristics of the reach may also be important in reach specification. The matrices can be applied to a variety of upland or lowland catchments respectively including those dominated by groundwater, and can be applied until the tidal limit.

In addition to the information provided by summary flow statistics in the matrix, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details and river gauging data have also been used to characterise the likely nature of the drought order / permit impacts.

If the drought order / permit does not impact on the magnitude of low flows in a watercourse, but does cause changes in the duration of low flow periods (which can be quantified), then the matrix in **Figure A.5** may be appropriate. The assessment is based on the percentage increase in the number of days for which flow is at or below the low flow (Q95) value. Typically this would be the case when the low flow regime in a watercourse downstream of a reservoir is protected by a statutory compensation release from the reservoir, but the reservoir may be drawn down below top water level for longer periods due to increased direct abstraction under the drought order / permit conditions.

If low flows in a watercourse are adversely affected in both magnitude and duration, then the impacts on magnitude are always used to determine the significance of hydrological impacts, using the appropriate matrix from **Figures A.1** to **A.4** inclusive. **Figure A.5** is only used when the impacts on low flows are on duration only.

Figure A.5 Hydrological Assessment Matrix (Low Flow Duration)

Percentage increase in low flow duration	Significance
<5%	Negligible
5-10%	Minor
10-25%	Moderate
>25%	Major

Intermittently flowing watercourse hydrological methodology

This methodology is applied to watercourses, potentially impacted on by the drought order / permit, that flow for most of the time but seasonally or occasionally ceasing to flow in response to decreased water availability e.g. due to increased evapotranspiration or bed seepage. . Such watercourses are identified from previous investigations and available data. Examples of watercourses where this methodology would be applied include winter bournes or watercourses that dry along their route due to losses to underlying aquifers. The impact classification of this methodology is as follows:

- Major - If the drought order / permit resulted in sections drying that did not dry up anyway
- Moderate - If the drought order / permit resulted in sections drying earlier (by more than a week) and / or recovering later (by more than a week) and hence flow reduction occurring in the channel for more than a week
- Minor - If the drought order / permit resulted in sections drying earlier (up to a week) and/or recovering later (by up to a week) and hence flow reduction occurring in the channel for up to a week OR if the drought order / permit were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought order / permit)
- Negligible - No significant impact

In addition to the derived classifications, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details, available data and findings of previous investigations. These have been used to characterise the likely nature of the drought order / permit impacts.

Reservoir hydrological methodology

More recently Cascade has developed a similar approach to categorise the significance of hydrological impacts of drought order / permit operations on reservoirs. The assessment requires an estimate of the relative change in duration of reservoir drawdown (i.e. the period for which water in the reservoir is below top water level), and the percentage decrease in the minimum reservoir level reached during the drawdown period. These two parameters are then compared against the reservoir impacts hydrological assessment matrix in **Figure A.6**.

This approach would be a suitable method to assess the impacts of a drought order / permit which involves significant changes to the reservoir water level regime (that would not normally be experienced during a drought without any additional measures implemented). For example, a drought order / permit may involve increasing daily or annual licensed abstraction limits to allow an increased rate of direct abstraction from the reservoir. This may enable some or all of a reservoir's emergency storage volume to be utilised, but is likely to lead to both lower water levels and increased periods of time below top water level.

Figure A.6 Hydrological Assessment Matrix (Reservoir Impacts)

	% Increase in duration of reservoir drawdown			
% Decrease in minimum reservoir level	<5%	5-10%	10-25%	>25%
<5%	Negligible	Negligible	Minor	Moderate
5-10%	Negligible	Minor	Moderate	Major
10-25%	Minor	Moderate	Major	Major
>25%	Moderate	Major	Major	Major

Additional Considerations

For groundwater schemes, hydrogeological data, where available, has been reviewed to inform the study area and duration of any impacts (noting impacts on groundwater may extend beyond the six month period of drought order / permit implementation - see below). An increase in groundwater abstractions would lead to an increased cone of depression in groundwater levels for groundwater abstraction. This impact can affect other non-surface water receptors such as other wells, springs or groundwater dependent ecosystems. It could also mean that surface water impacts would extend upstream of the abstraction point or, in significant instances, to other watercourses some distance from the abstraction.

For groundwater abstractions, the impact of a drought order / permit could extend beyond the six month period (time limited) of abstraction depending on the local hydrogeology of the area. During drought situations, where there is limited recharge to the aquifer system, the abstraction can be mainly at the expense of groundwater stored in the aquifer. This can, in the long run, delay groundwater level recovery and have a knock on effect on baseflow contributions to watercourses. Flows could, therefore, be reduced for longer than the six month period during which the drought order / permit could be implemented and, as such, has been considered as part of the assessment described in this report.

APPENDIX B
HYDROLOGY AND PHYSICAL ENVIRONMENT ASSESSMENT

B1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of the Llyn Aled and Aled Isaf Reservoirs and the Afon Aled river catchment, and the Plas Uchaf and Dolwen Reservoirs and their catchment, during the period of implementation of the drought permit and subsequent reservoir level recovery.

For the purposes of this assessment, the "without drought permit" baseline includes the continuation of daily abstraction at Bryn Aled intake on Afon Aled, for transfer to Plas Uchaf Reservoir for potable supply, under normal licence conditions and operating arrangements including compensation, fisheries and regulation releases from Aled Isaf Reservoir. However, the baseline assumes higher demands than usual which would exceed the annual licence conditions before the end of the year; under the baseline scenario, abstractions cease once the annual licensed quantity has been abstracted. The assessed drought permit involves a temporary increase of 1000Ml in annual licence conditions on Welsh Water's Bryn Aled river intake and Plas Uchaf and Dolwen reservoir abstractions, to allow the continuation of Welsh Water's abstraction at up to the maximum daily demands, until cumulative annual licence volumes are reset on 1 April (Bryn Aled) and 1 January (Plas Uchaf) the following year.

B.1.1 Welsh Water's Existing Operations

Welsh Water abstract water from the Afon Aled at Bryn Aled intake to pump to Plas Uchaf Reservoir. From Plas Uchaf Reservoir water gravitates to Glascoed Water Treatment Works, which supplies the Clwyd Coastal water resources zone (WRZ) (average demand 19.8Ml/d in 2012/13). The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions:

- 4,318 million litres (Ml) authorised to be abstracted per annum
- Maximum daily abstraction rate of 27.3Ml/d
- The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following:
    - A fixed statutory compensation water discharge of 2.27Ml/d at all times for the general benefit of riparian interests
    - Regulation releases to support the abstraction at Bryn Aled that include the following scenarios

    - 1 February to 31 May inclusively when the Bryn Aled intake is in operation: controlled releases from Aled Isaf Reservoir maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake

    - 1 June to 31 January inclusively when flow at Bryn Aled weir is less than

29.5Ml/d: daily regulation releases from Aled Isaf Reservoir shall not be less than the daily abstraction rate at Bryn Aled intake

- Fisheries management and angling releases. These are made up of a maximum of 354Ml for freshet releases and an additional special release allocation, the volume of which varies each month depending on the reservoir levels (see S20 operating manual).

The abstraction of water is taken from the Afon Aled at the Bryn Aled intake and transferred to Plas Uchaf impounding reservoir. Water from Plas Uchaf reservoir is abstracted and treated at Glascoed water treatment works (WTW) for public supply. Abstraction at the Bryn Aled intake is typically continuous during the summer and autumn period. The abstraction rate is typically 9.2Ml/d, the capacity of the smaller of the two abstraction pumps. The bigger, variable speed pump is used for larger abstractions when required, up to 16Ml/d. In winter, abstractions are still required to support the potable supply but are made at a lower rate.

Compensation, regulation and freshet releases from Aled Isaf Reservoir are controlled through a series of manually operated valves on the reservoir drawoff tower. These are measured prior to release to the Afon Aled.

Freshet releases are made from a bank of water reserved in the licence under the terms of the Section 20 Operating Agreement with NRW. Welsh Water control the basic fisheries release seasonally. Fisheries releases are specified by NRW but typically a flow of 3.8Ml/d is released continuously during the period 1 July to 15 September and a flow of 2.0Ml/d is released continuously during the period 16 September to 16 October. Outside these periods NRW can request additional freshet releases from 1 April, providing they are within the maximum allocation of 354 Ml.

During the period 28 August to 25 January, a series of valves in the Aled Isaf Reservoir drawoff tower are kept open for flood mitigation. These releases are also made through the flow measurement structure. At high reservoir levels (above the spillway crest level) excess water spills from Aled Isaf Reservoir to the Afon Aled.

Llyn Aled Reservoir is located approximately 1km upstream of Aled Isaf Reservoir on the Afon Aled. Together, these two reservoirs provide a total live storage volume of 2,862Ml for controlling releases to the Afon Aled from Aled Isaf Reservoir. There are no licensed controls on the operation of Llyn Aled Reservoir. Water is released through a manually operated drawoff from Llyn Aled Reservoir and flows through an open channel (a channelised section of the Afon Aled) to Aled Isaf Reservoir. Releases should only be made when the level in Aled Isaf Reservoir drops below 10 metres and subsequent releases should then be made to maintain the level between 8 and 10 metres.

Welsh Water also has two licences for the abstraction of water from local streams to supplement inflow to Llyn Aled Reservoir. These licences are not affected by this drought permit.

The Plas Uchaf Reservoir and Dolwen Reservoir abstraction licence (number 24/66/6/7/S, variation no. 2) includes the following conditions:

- 5000 million litres (Ml) authorised to be abstracted per annum.
- Maximum daily abstraction rate of 22Ml/d.

There are no statutory compensation release requirements relating to the abstractions from Plas Uchaf and Dolwen reservoirs.

The annual licences on Bryn Aled intake and Plas Uchaf and Dolwen reservoirs can support annual average abstractions of up to 11.8Ml/d and 13.7Ml/d respectively.

B.1.2 Welsh Water's Proposed Drought Permit Operations

The drought permit involves a temporary increase of 1000Ml in the annual licensed quantities permitted to be abstracted under both the Bryn Aled intake and Plas Uchaf and Dolwen Reservoir abstraction licences, such that abstractions up to the daily maximum demands would be permitted all year round. This would enable Welsh Water to continue to abstract from the Aled catchment to meet higher than usual demands in drought conditions. The drought permit scheme will potentially influence water levels in Llyn Aled, Aled Isaf, Plas Uchaf and Dolwen Reservoirs and flows in the Afon Aled and Dolwen/Plas Uchaf catchments.

The timing of the temporary increase in the annual licence conditions will not occur prior to the 6th September for the Bryn Aled intake, and the 16th August for the Plas Uchaf and Dolwen reservoirs, as the annual licence quantities can sustain the daily maximum rates until these dates. Furthermore, Welsh Water have determined through water resources modelling that this drought permit is most likely to be implemented during the period November – March. However, for Plas Uchaf and Dolwen reservoirs the drought permit licence conditions would only be required until 1st January in the following year, as the cumulative annual abstraction volumes are reset at the start of each year., Potential impacts on flow and water level need to be considered for the period between 1st November and 31st March (cumulative abstraction volumes for Bryn Aled intake would be reset on 1 April).

The assessment includes Llyn Aled Reservoir, Aled Isaf Reservoir, the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy, Plas Uchaf and Dolwen Reservoirs and their stream catchment from the Dolwen reservoir outflow to the confluence with the Afon Elwy. The study area is shown on **Figure B1.1**. Consideration is also given to a tributary, Afon Deunant, which joins the Afon Aled downstream of the Aled Isaf Reservoir and upstream of the abstraction intake at Bryn Aled.

The physical environment includes consideration of hydrology and hydrodynamics; geomorphology; and water quality. The assessment has three key objectives:

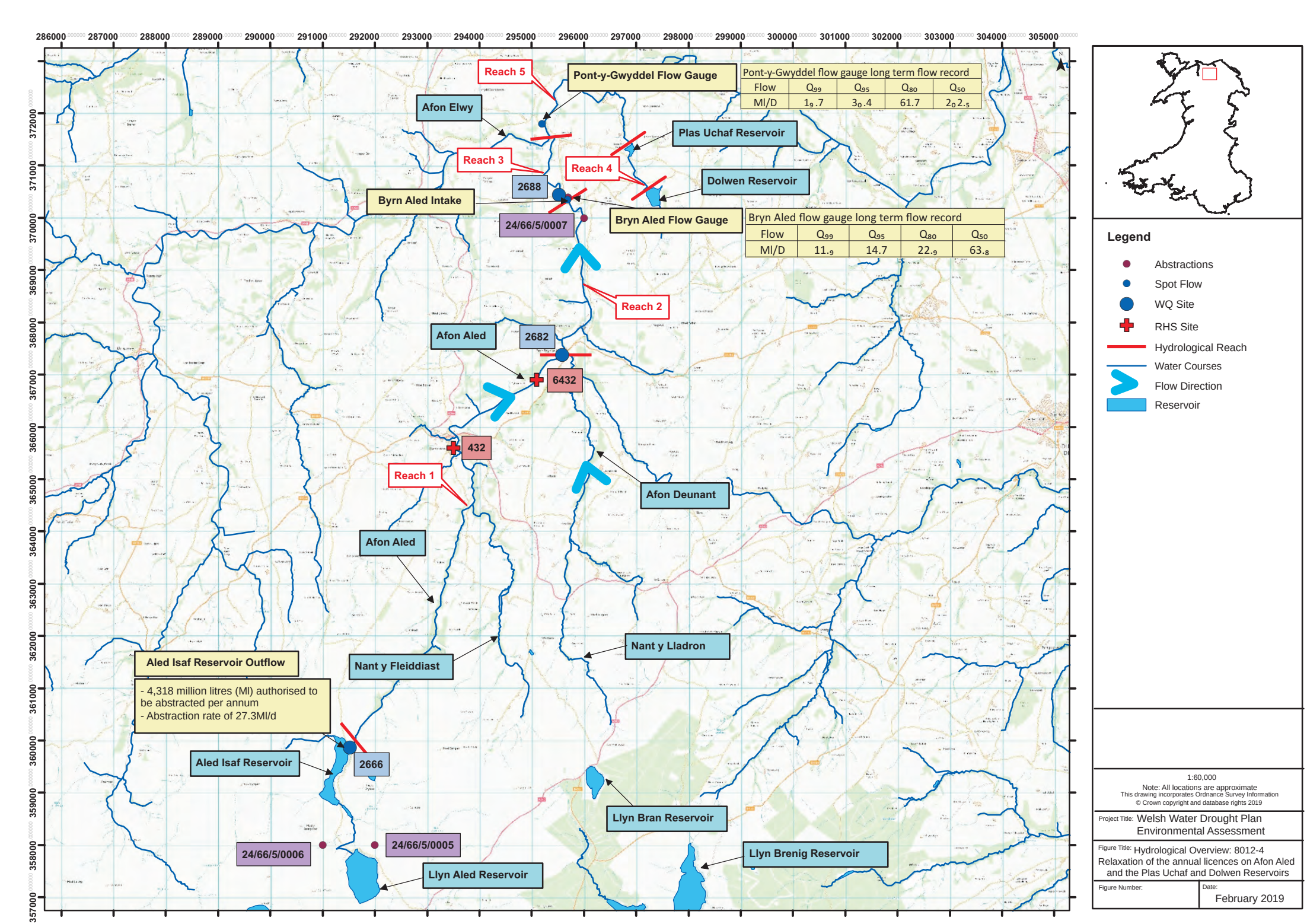
1. To "list the likely impacts to the flow, level, channel/riparian form and sediment due to

action being in place" as required by the DPG[1] and set out in Figure 2 of the DPG.

2. To support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report.
3. To provide supporting technical information for the screening and assessment of sensitive physical environmental features.

This appendix is set out in the following sections:

[1] Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000, Accessed 04 February 2019.


Reach 5
Pont-y-Gwyddel Flow Gauge
Afon Elwy
Plas Uchaf Reservoir
Reach 3
Reach 4
2688
Dolwen Reservoir
Byrn Aled Intake
Bryn Aled Flow Gauge
24/66/5/0007
Reach 2
Afon Aled
2682
6432
432
Reach 1
Afon Deunant
Afon Aled
Nant y Lladron
Nant y Fleiddiast
Aled Isaf Reservoir Outflow
- 4,318 million litres (Ml) authorised to be abstracted per annum
- Abstraction rate of 27.3Ml/d
Aled Isaf Reservoir
2666
Llyn Bran Reservoir
24/66/5/0006
24/66/5/0005
Llyn Brenig Reservoir
Llyn Aled Reservoir
Pont-y-Gwyddel flow gauge long term flow record
Flow | Q99 | Q95 | Q80 | Q50
Ml/D | 19.7 | 30.4 | 61.7 | 202.5
Bryn Aled flow gauge long term flow record
Flow | Q99 | Q95 | Q80 | Q50
Ml/D | 11.9 | 14.7 | 22.9 | 63.8
Legend
Abstractions
Spot Flow
WQ Site
RHS Site
Hydrological Reach
Water Courses
Flow Direction
Reservoir
1:60,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
© Crown copyright and database rights 2019
Project Title: Welsh Water Drought Plan Environmental Assessment
Figure Title: Hydrological Overview: 8012-4 Relaxation of the annual licences on Afon Aled and the Plas Uchaf and Dolwen Reservoirs
Figure Number:
Date: February 2019

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

Llyn Aled and Aled Isaf Reservoirs

The Llyn Aled and Aled Isaf reservoirs are located in the county of Conwy, North Wales, to the south-west of the Clwyd Coastal WRZ which includes Prestatyn and Rhyl. The reservoir system is fed by a 12km^2 headwater catchment, which ranges in altitude from 350m to 496m and is covered by moorland, heath and unimproved grassland. Llyn Aled Reservoir is the upper reservoir at an altitude of 373m and has a surface area of 45 ha. Aled Isaf Reservoir is the lower reservoir, directly linked to Llyn Aled Reservoir by a 1km channelised section of the Afon Aled. Aled Isaf Reservoir is at an altitude of 366m and has a surface area of 26ha. The total usable storage volume of the two reservoirs is 2,862Ml, approximately 60% of this storage is in the Llyn Aled Reservoir (1726Ml) whilst the storage capacity of Aled Isaf Reservoir is 1136Ml. The presence of the two reservoir dams introduces discontinuity between the headwater catchment and the downstream river system.

Afon Aled

The Afon Aled is a 14.7km long, stretching from the outlet at Aled Isaf Reservoir flowing north to the confluence with the Afon Elwy just upstream of the Pont-y-Gwyddel flow gauge, with a catchment area of 145km^2, draining upland areas. The Afon Elwy continues downstream for 20km, flowing into the Clwyd Estuary and Liverpool Bay at Rhyl.

Plas Uchaf and Dolwen Reservoirs

The Plas Uchaf and Dolwen reservoirs are located in the county of Conwy, North Wales, to the south of the coastal town of Abergele. Dolwen Reservoir, sited at an altitude of 168m, has a surface area of 7.3ha and a storage capacity of 288Ml. Any overflow from Dolwen Reservoir flows down a short unnamed stream into Plas Uchaf Reservoir, at an altitude of 148m, which has a surface area of 2.1ha and a capacity of 212Ml. The overall catchment area of the two reservoirs is 3.59km^2 (2.28km^2 for Dolwen Reservoir alone).

Generally the Dolwen/Plas Uchaf reservoir system is managed so that there is no spill. However, if there is any occasional overflow, it flows down a small unnamed stream and joins the Afon Elwy, a couple of kilometres downstream of the Afon Aled confluence.

The natural inflows to Plas Uchaf and Dolwen are supplemented by the Bryn Aled abstraction which is pumped into Plas Uchaf. The water is then abstracted from here and treated at Glascoed WTW.

B.2.1.2 Baseline Data Availability

Continuous monitoring is undertaken by Welsh Water to monitor its operations in the Afon Aled catchment namely:

- Daily Llyn Aled Reservoir water level data 2001-present;
- Daily Aled Isaf Reservoir water level data 1989-present;
- Daily Plas Uchaf Reservoir water level data 2000-present;
- Daily Dolwen Reservoir water level data 2000-present;
- Daily controlled outflow data from Aled Isaf Reservoir (compensation releases, regulation releases, freshet releases and flood mitigation releases combined) 1995-present;
- Daily abstraction data from Bryn Aled intake 1989-2015;
- Daily flows to Glascoed WTW 2005-2015;
- Bryn Aled flow gauge; daily river flow data 1990-present.

In addition, Natural Resources Wales (NRW) operate a flow gauge on the Afon Elwy, 300m downstream of the confluence with the Afon Aled:

- Pont Gwyddel flow gauge; daily river flow data 1973-present.

The reference conditions of Llyn Aled Reservoir, Aled Isaf Reservoir, Plas Uchaf Reservoir and Dolwen Reservoir and the Afon Aled and Afon Elwy catchments are summarised below.

B.2.1.3 Hydrology

Llyn Aled Reservoir

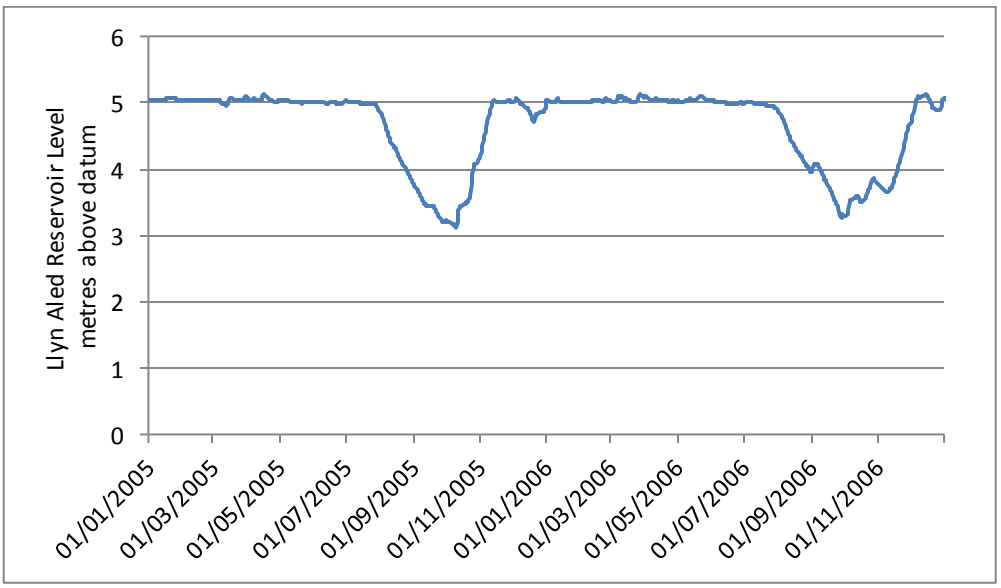
Typically reservoir levels range from about 3m to about 5m (data from 2001 – 2015) above datum in Llyn Aled, the upper of the two reservoirs in the catchment. The top water level is at 5m above datum and when the reservoir is at full capacity, any overflows pass down the channel linking the two reservoirs and form part of the inflow to Aled Isaf. A summary of reservoir levels is given in **Table B2.1** below. This data includes the manual readings from 1995-1996; the lowest level recorded in 1995 was 2.1m.

Table B2.1 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Llyn Aled Reservoir (January 1995 – December 1996 and February 2001 – December 2015)

Percentage of time lake level equalled or exceeded	Mean daily reservoir level, metres, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum reservoir level	5.2	5.2	5.1	5.3	5.2	5.2	5.2	5.1	5.2	5.1	5.2	5.1	5.3
10% (high level)	5.1	5.1	5.1	5.1	5.1	5.0	5.1	5.0	5.0	5.1	5.1	5.1	5.1
50%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.7	4.5	5.0	5.0	5.0
80%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.5	3.9	3.8	4.5	5.0	4.9
90%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.2	3.5	3.5	4.1	4.9	4.4
95%	5.0	5.0	5.0	5.0	4.9	5.0	5.0	4.0	3.3	3.2	3.8	4.7	4.0
99% (low level)	4.1	5.0	5.0	4.9	4.8	4.8	4.9	3.8	3.1	3.0	3.4	3.3	3.3
Minimum reservoir level	3.4	4.0	5.0	4.9	4.7	4.8	4.7	3.5	2.1	2.4	2.7	3.2	2.1

Figure B2.1 illustrates the typical drawdown patterns in Llyn Aled over the period 2005–2006. The lowest levels (below 4.0m) are understood to be due to reservoir drawdown for dam maintenance works.

Figure B2.1 Llyn Aled Reservoir Level (1 January 2005 to 31 December 2006)



Aled Isaf Reservoir

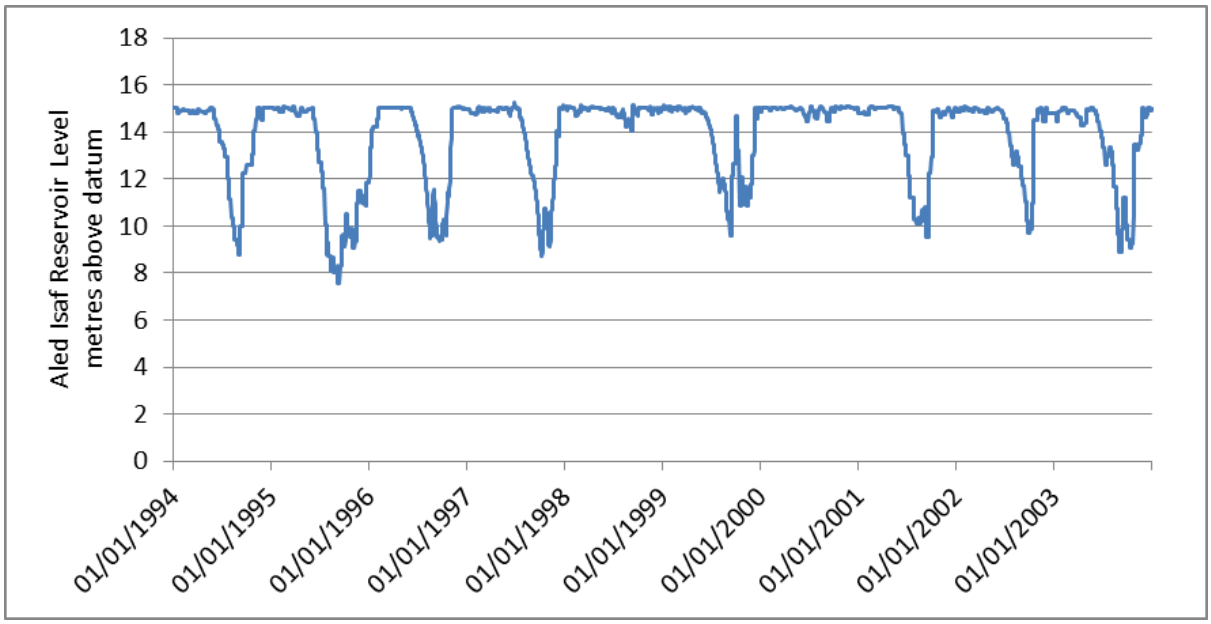
Top water level at Aled Isaf (at which overflow occurs) is at about 15 m. Typically reservoir levels in Aled Isaf range from around 8 m up to 15 m (see also **Table B2.2**). The lowest levels of 2m are understood to be due to reservoir drawdown for dam maintenance works in 1992/93; lowest levels experienced during the critical drought period of 1995/1996 were around 8m.

Table B2.2 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Aled Isaf Reservoir (January 1989 – November 2015)

Percentage of time lake level equalled or exceeded	Mean daily reservoir level, metres, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum reservoir level	15.2	15.2	15.2	15.1	15.1	15.2	15.1	15.1	15.2	15.1	15.2	15.1	15.2
10% (high level)	15.0	15.1	15.1	15.1	15.0	15.0	14.7	14.6	14.8	15.0	15.0	15.0	15.0
50%	14.9	15.0	15.0	15.0	15.0	14.3	12.9	11.5	11.1	12.5	14.0	14.8	14.7
80%	14.5	14.9	14.8	14.8	14.6	13.4	11.3	9.5	9.2	9.8	11.5	12.8	12.1
90%	13.3	14.6	14.7	14.3	14.1	12.9	10.3	8.4	8.8	9.0	9.3	11.5	10.1
95%	12.1	12.8	13.9	13.9	13.8	12.7	9.3	5.7	7.6	7.4	8.3	11.0	9.2
99% (low level)	11.4	11.4	13.1	12.6	12.1	12.0	6.5	3.9	6.6	6.8	7.6	10.1	6.8
Minimum reservoir level*	10.5	11.2	12.3	12.4	11.8	10.9	2.0	2.0	5.1	6.4	6.5	7.5	2.0

Figure B2.2 illustrates the typical drawdown patterns in Aled Isaf over the period 1994–2003.

Figure B2.2 Aled Isaf Reservoir Level (1 January 1994 to 31 December 2003)



Plas Uchaf and Dolwen Reservoirs

Typically water levels at Plas Uchaf do not vary much, ranging from about 14m to 15m above datum in most years (top water level being at 15m), although levels did drop to about 13.8m

in February 2016. There is more variation in Dolwen Reservoir, with water levels ranging from 10.7m to 15m above datum (top water level being at 15m) during the period 2000-2016. (See also **Tables B2.3** and **B2.4**).

Table B2.3 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Plas Uchaf Reservoir (2000 –2016)

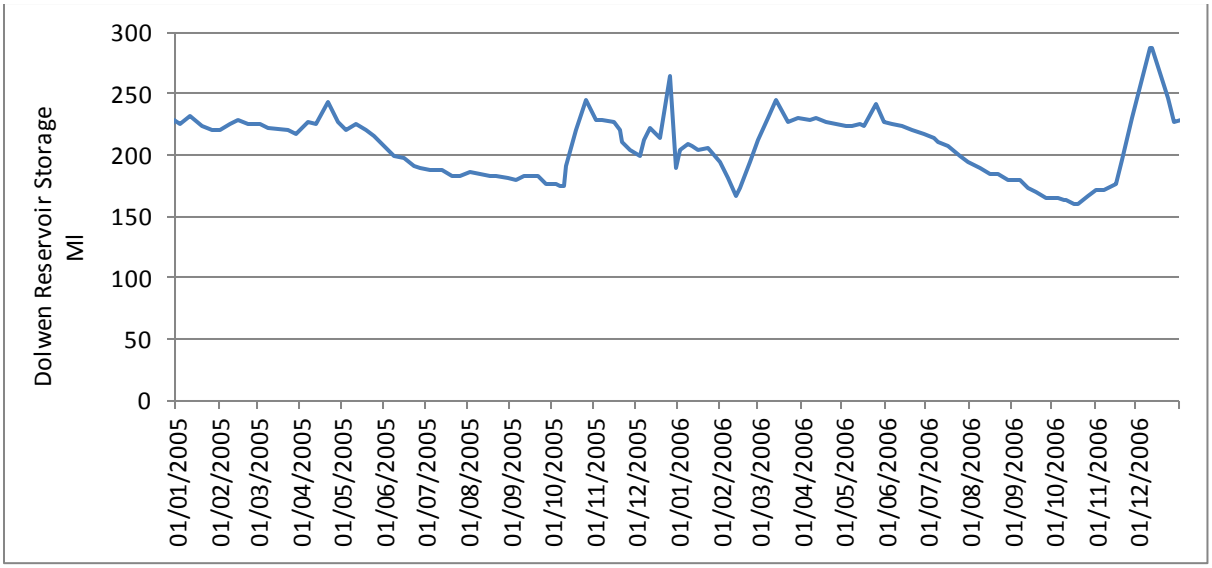
Percentage of time lake level equalled or exceeded	Mean daily reservoir level, metres, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum reservoir level	15.1	15.1	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.1	15.1	15.1	15.1
10% (high level)	14.9	15.0	14.9	14.9	14.9	14.9	14.9	14.9	14.9	15.0	15.0	15.1	15.0
50%	14.8	14.8	14.8	14.8	14.7	14.7	14.8	14.7	14.7	14.8	14.7	14.8	14.8
80%	14.7	14.7	14.6	14.6	14.6	14.6	14.5	14.5	14.5	14.6	14.4	14.7	14.6
90%	14.6	14.6	14.6	14.6	14.5	14.5	14.4	14.4	14.4	14.5	14.4	14.6	14.5
95%	14.5	14.5	14.5	14.5	14.5	14.4	14.3	14.4	14.3	14.4	14.3	14.6	14.4
99% (low level)	14.4	14.2	14.3	14.4	14.0	14.2	14.3	14.1	14.1	14.1	14.3	14.4	14.2
Minimum reservoir level	14.3	13.8	14.2	14.3	14.0	14.2	14.2	14.0	14.1	14.1	14.3	14.0	13.8

Table B2.4 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Dolwen Reservoir (2000 –2016)

Percentage of time lake level equalled or exceeded	Mean daily reservoir level, metres, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum reservoir level	15.1	15.0	14.9	14.5	14.3	15.0	14.2	14.1	14.7	14.7	15.1	15.1	15.1
10% (high level)	14.9	15.0	14.1	14.1	14.1	14.0	14.0	14.0	14.0	14.1	14.2	14.8	14.4
50%	14.1	14.1	14.0	14.0	13.9	13.8	13.4	13.3	13.0	13.2	13.9	14.1	14.0
80%	14.1	14.1	14.0	13.9	13.7	13.0	12.7	12.4	12.2	12.0	12.7	14.0	13.0
90%	14.0	14.0	13.9	13.6	13.0	12.8	12.5	11.9	11.2	10.9	12.3	13.6	12.4
95%	13.8	13.9	13.8	13.4	13.0	12.7	12.3	11.5	11.1	10.8	11.4	13.3	12.1
99% (low level)	13.4	13.2	12.8	13.1	12.8	12.5	12.0	11.3	11.0	10.7	10.7	13.0	10.9
Minimum reservoir level	13.2	13.1	12.8	13.1	12.8	12.4	12.0	11.3	10.9	10.7	10.7	12.8	10.7

Figure B2.3 illustrates the typical drawdown patterns in Dolwen Reservoir over the period 2005– 2006.

Figure B2.3 Dolwen Reservoir Storage (2005 to 2006)



Afon Aled

Flow in the Afon Aled is measured at Bryn Aled, just downstream of Welsh Water's abstraction intake. A summary of key flow statistics for this site is provided in **Table B2.5,** and the flow duration curve is shown in **Figure B2.4**. A hydrograph of flows in a typical dry year (1996) is shown in **Figure B2.5**.

Table B2.5 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Aled at Bryn Aled gauging station (October 1990 – October 1999 and November 2000- November 2015)

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	1313.5	1079.6	1099.5	896.0	494.3	1055.7	934.6	434.2	1075.8	997.5	1446.3	1173.3	1446.3
10% (high flow)	478.7	407.5	229.1	198.2	129.6	104.1	96.2	55.5	116.9	254.9	366.7	503.7	280.4
50%	170.0	104.7	76.6	59.9	39.3	26.2	20.4	22.9	29.1	66.1	129.6	168.0	62.9
80%	91.3	60.1	48.0	26.0	20.6	17.1	15.5	15.4	16.4	29.3	69.4	77.2	22.8
90%	61.0	44.6	34.2	19.2	15.9	14.6	13.3	13.8	14.5	20.8	57.3	63.8	16.6
95% (low flow)	40.2	34.0	27.8	16.1	13.2	13.0	11.7	13.0	12.9	15.9	46.2	56.5	14.4
99% (extreme low flow)	29.1	25.9	15.9	13.4	11.8	9.3	10.3	11.2	10.9	12.7	22.1	39.8	11.5
Minimum flow	25.6	15.8	13.0	12.4	9.7	8.4	8.5	8.5	7.9	11.0	16.6	16.7	7.9

The key flow statistics for the summer period (April – September inclusive) are: Q_{95} = 13.1 Ml/d, and Q_{99} = 10.5 Ml/d.

Figure B2.4 Flows in the Afon Aled at Bryn Aled Gauging Station (2000-2015)

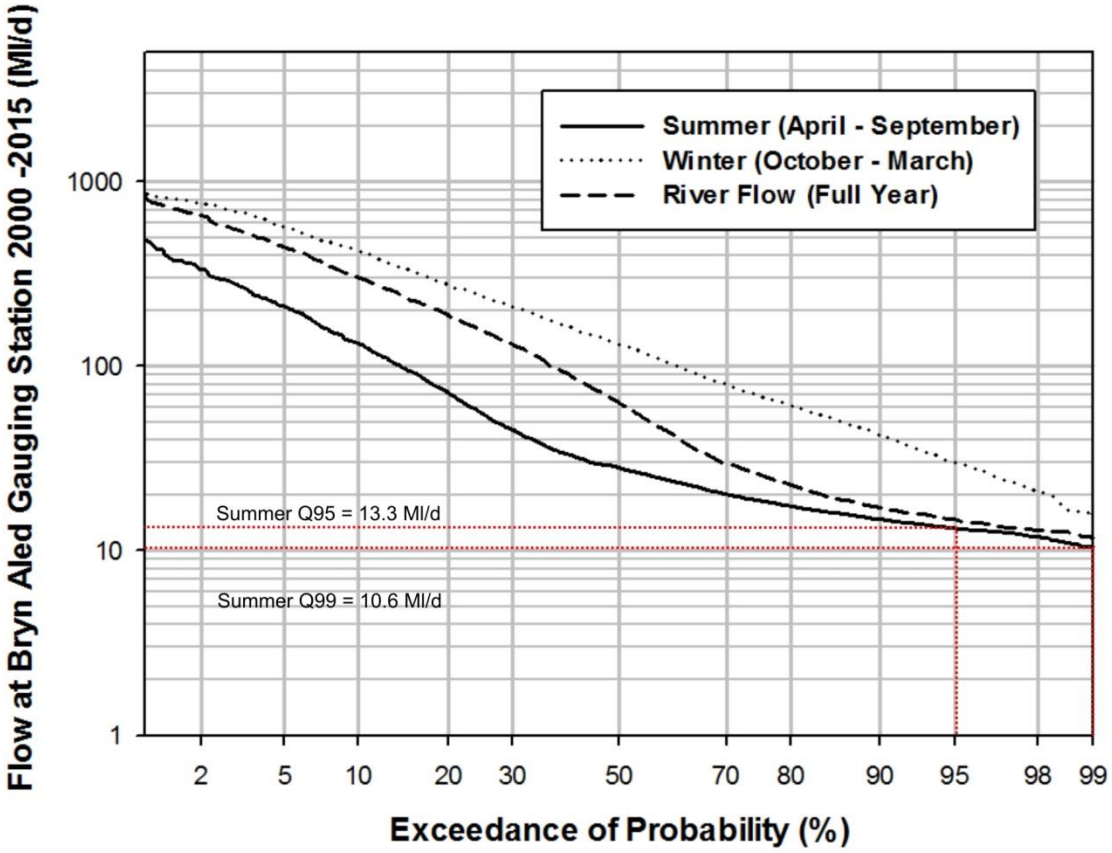
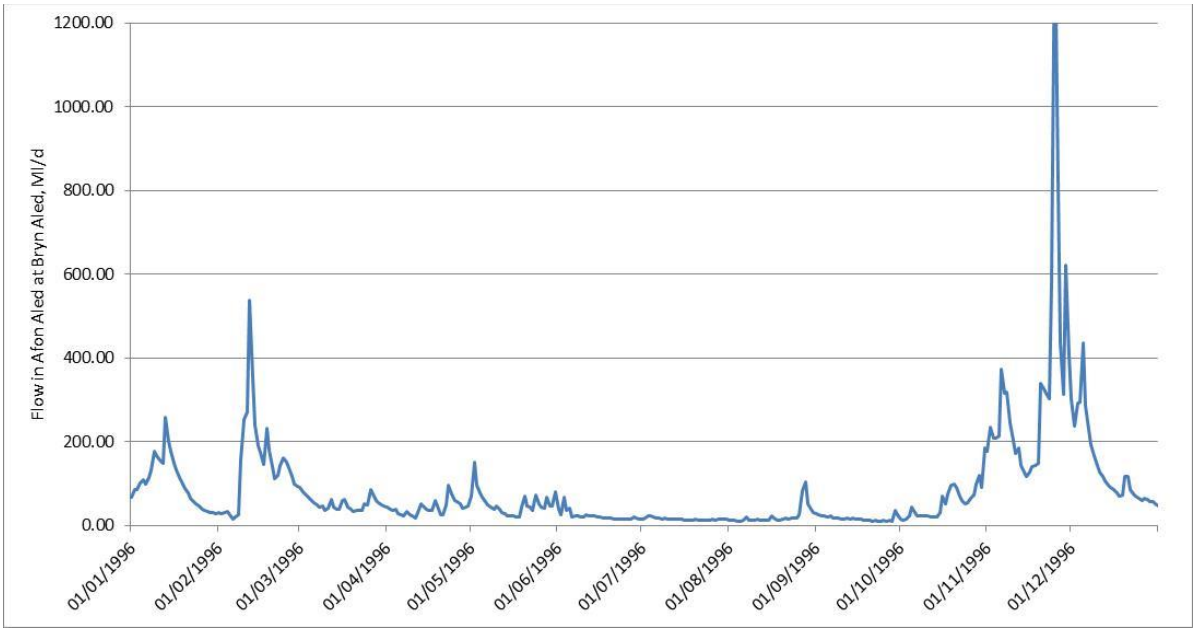


Figure B2.5 Afon Aled at Bryn Aled Gauging Station (1996)



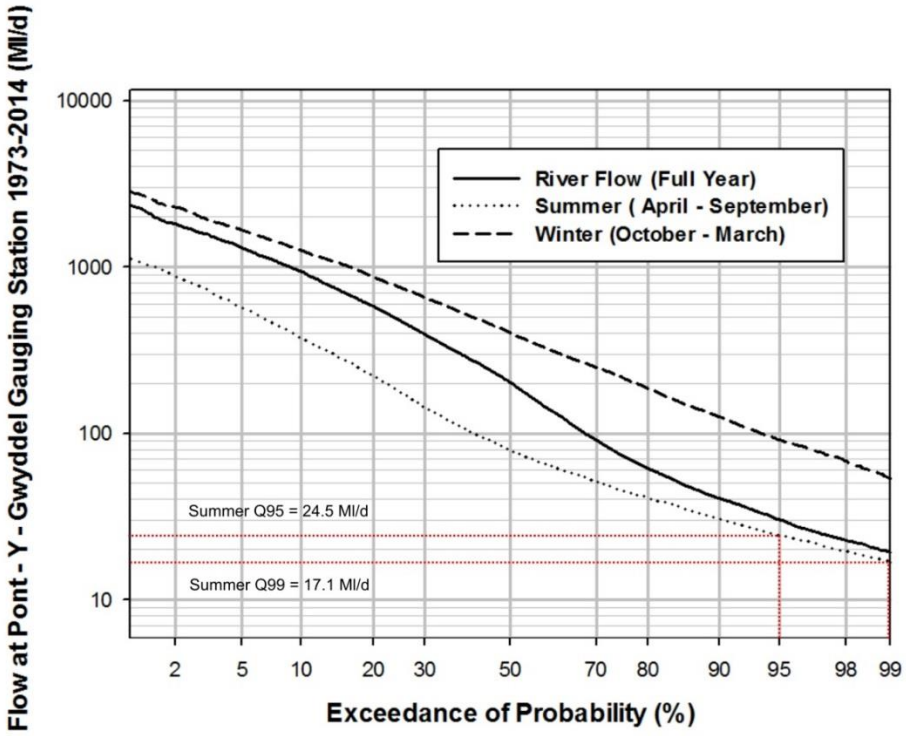
Afon Elwy

NRW continuously monitor river flow on the Afon Elwy at the Pont-y-Gwyddel flow gauging station which is 14.7km downstream of Aled Isaf Reservoir. The Pont-y-Gwyddel gauging station is a velocity-area station with 1m wide Crump weir blocks set within a 10m wide archway to achieve low flow sensitivity. **Table B2.6** gives the key flow statistics for this location, and the flow duration curve is shown in **Figure B2.6**.

Table B2.6 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Elwy at Pont-y-Gwyddel gauging station (November 1973- December 2014)

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	5111.4	5978.9	3475.0	2980.8	1399.7	5106.2	3611.5	1958.7	4121.3	6404.0	8156.2	3881.1	8156.2
10% (high flow)	1508.5	1183.3	872.6	606.3	346.2	239.4	161.6	236.9	472.0	1008.3	1270.4	1499.6	937.4
50%	532.8	365.8	266.7	191.9	102.0	67.0	48.6	58.4	90.1	266.1	471.9	552.8	202.5
80%	290.1	196.6	146.1	81.9	58.1	41.0	32.1	28.7	40.3	104.1	239.3	266.1	61.7
90%	204.9	145.8	111.0	60.4	46.0	33.4	26.8	23.1	26.8	72.1	162.4	197.3	40.7
95% (low flow)	129.9	114.2	90.1	51.0	40.2	27.2	23.1	18.7	22.3	53.4	119.2	153.9	30.4
99% (extreme low flow)	84.4	83.2	62.7	42.4	33.2	19.9	14.9	14.8	17.7	28.5	79.1	88.1	19.7
Minimum flow	67.8	63.4	45.4	28.9	29.9	14.9	8.3	7.4	10.6	17.4	57.2	75.8	7.4

Figure B2.6 Flows in the Afon Elwy at Pont-y-Gwyddel Gauging Station (1973-2014)



Contributing sub-catchment areas at key points in the Afon Aled and Afon Elwy catchments are shown in **Table B2.7**.

Table B2.7 Afon Aled and Afon Elwy – Sub-catchment Areas

Watercourse	Location	Grid Reference	Sub-catchment Area (km²)
Afon Aled	Immediately downstream of Aled Isaf Reservoir outflow	SH915599	11km²
Afon Aled	Upstream of the Afon Aled – Afon Deunant confluence	SH956674	39km²
Afon Deunant	Afon Deunant upstream of the Afon Aled – Afon Deunant confluence	SH957674	18km²
Afon Aled	Bryn Aled flow gauge	SH958701	70km²
Afon Aled	Lower hydrological reach 2	SH954715	72km²
Afon Elwy	Upstream of the Afon Elwy – Afon Aled confluence	SH953715	118km²
Afon Elwy	Pont-y-Gwyddel Gauging Station	SH952717	194km²
Unnamed stream, Dolwen catchment	Immediately downstream of Dolwen Reservoir	SH972706	2.3km²
Unnamed stream, Dolwen catchment	Immediately downstream of Plas Uchaf Reservoir	SH968714	3.6km²
Unnamed stream, Dolwen catchment	Upstream of confluence with Afon Elwy	SH966724	4.6km²

B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

A review of the flows and physical habitat characteristics of the river network downstream of the Aled Isaf Reservoir and Plas Uchaf and Dolwen Reservoirs has identified the likely hydrological zone of influence of the drought permit, which has been used to define the study area. The study area includes a length of the Afon Aled and the unnamed stream below Dolwen Reservoir, and comprises five distinct hydrological reaches as identified on **Figure B1.1**:

- Reach 1 is the 10.1km stretch of the Afon Aled as it flows between Aled Isaf Reservoir and the confluence with Afon Deunant.
- Reach 2 is the 3km stretch of the Afon Aled between the confluence with the Afon Deunant and the Bryn Aled intake.
- Reach 3 is the 1.6km stretch of the Afon Aled as it flows between the Bryn Aled intake and the confluence with the Afon Elwy.
- Reach 4 is the short (<0.5km) stretch of the unnamed stream between Dolwen Reservoir outflow and the inlet to Plas Uchaf Reservoir.
- Reach 5 is the short (approx. 1km) stretch of the unnamed stream between Plas Uchaf Reservoir outflow and the confluence with the Afon Elwy.

The Afon Aled flows into the Afon Elwy 1.6km downstream of the Bryn Aled intake. The Afon Elwy is a larger river system than the Afon Aled, and changes to the flow regime in the Aled

and Plas Uchaf/Dolwen catchments are not considered likely to have a significant impact on flows in the Afon Elwy. This watercourse has been excluded from further assessment.

During periods of low effective rainfall, the majority of flow in the Afon Aled is supported by controlled releases from Aled Isaf Reservoir. During such periods, flow accretion from the surrounding catchment is low and contribution from tributaries to the Afon Aled, including the Afon Deunant, is minor.

The potential hydrological impacts of the drought permit options have been assessed for each of the four reservoirs and five separately identified river reaches of the Afon Aled and unnamed stream in the Plas Uchaf/Dolwen catchment, as summarised in **Table B2.9** at the end of this section.

The details of the assessment for each reach are presented below.

B.2.2.2 Hydrological Impact Assessment

The impacts of this drought permit will only occur during that part of the year between the date when the full annual licensed quantity has been abstracted, and the 31st December (Plas Uchaf licence) or 31st March (Bryn Aled licence), as the annual cumulative abstracted quantities are reset on 1st January and 1st April respectively for monitoring as part of the next year's abstractions. The date when the full annual licensed quantity has been abstracted will depend on the daily average abstraction from 1st January and 1st April respectively of the current year onwards, but assuming the daily maximum licensed quantity is not breached then this cannot occur before 6th September for the Bryn Aled intake or 16th August for the Plas Uchaf and Dolwen Reservoir abstraction.

In addition, the date on which the full Bryn Aled annual licensed quantity is abstracted depends on the daily average quantity which is available from the Plas Uchaf/Dolwen system. Any resource provided from that reservoir system will reduce the amount required from the Bryn Aled abstraction to support the required flow to Glascoed WTW, to meet demands in the area supplied by the works. The proportion of Glascoed WTW supply which is met from the natural inflows to Plas Uchaf/Dolwen is variable, and has varied from around 20% to 47% annually over the years 2005 – 2014 for which abstraction data is available. This equated to an annual average supply of between 2.3Ml/d to 5.5Ml/d; however, this period did not include any exceptionally dry years. For the purposes of this assessment we have assumed that a minimum annual average of 2Ml/d could be supplied from the natural inflows to Plas Uchaf/Dolwen, but this may potentially be even lower in exceptional drought conditions.

Table B2.8 indicates the variation in the date at which this drought permit could theoretically be required for the two abstraction licences, depending on the daily average abstraction/demand prior to that point, and assuming a minimum average supply of 2Ml/d from the Plas Uchaf/Dolwen catchment.

In recent years the daily average supply to Glascoed WTW, by calendar year between 2005 and 2014, has varied from 10.8Ml/d up to 13.1 Ml/d. (This excludes the supply from the Llannerch boreholes which is covered by a separate abstraction licence.) It can be seen from **Table B2.8** that these demands would not cause a breach in either the Bryn Aled or the Plas Uchaf/Dolwen licence, assuming a contribution of at least 2Ml/d of natural inflows to the Plas Uchaf/Dolwen system. However, if an average supply of over 13.7Ml/d is required then the annual licence quantities would not be sufficient, and an increase in the annual licence conditions would be required progressively earlier as average daily demands increase. The additional volume which would need to be abstracted in the remainder of the year, over and above the normal licensed quantity, is also shown in **Table B2.8** for the different values of average daily demand.

Table B2.8 Potential Exceedance Dates of Aled Annual Licence Conditions

Daily average supply to Glascoed WTW (Ml/d)	Date Bryn Aled licence exceeded (if at all)	Additional licensed volume required at Bryn Aled (Ml)	Date Plas Uchaf & Dolwen licence exceeded (if at all)	Additional licensed volume required at Plas Uchaf & Dolwen (Ml)
11.81	Not exceeded	0	Not exceeded	0
13.7	Not exceeded	0	Not exceeded	0
14	25-Mar	74	23-Dec	124
15	27-Feb	440	29-Nov	490
16	3-Feb	806	08-Nov	856
17	13-Jan	1172	21-Oct	1222
18	26-Dec	1538	4-Oct	1588
19	11-Dec	1904	20-Sep	1954
20	26-Nov	2270	7-Sep	2320
21	14-Nov	2636	26-Aug	2686
22	2-Nov	3002	15-Aug	3052

For daily average supply at Glascoed WTW in the range 14 – 18Ml/d, the drought permit influences occur only in the autumn and winter period from around the beginning of October to the end of March. The impact of the sustained period of high demands is that an additional volume of up to 1538Ml is required to be abstracted from the Aled system, relative to the position without the drought permit.

With even higher demands, of around 19Ml/d up to the potential maximum daily licence at Plas Uchaf and Dolwen Reservoirs of 22Ml/d, the additional volume required is considerably higher at up to 3002Ml (or 3052Ml including the assumed resource contribution from Plas Uchaf and Dolwen Reservoirs). As the combined total capacity of the four reservoirs under consideration is 3362Ml, and most of these reservoirs are likely to be already severely depleted under the high demands assumed under the baseline scenario, it is likely that there would be insufficient water physically available in the catchment to supply the additional volume. The additional abstractions at Bryn Aled would be dependent not only on fully utilising all the storage capacity of the Aled reservoir system but also on winter rainfall producing higher catchment inflows towards the end of the licensed period. The influences of the drought permit would occur from mid-August until mid-December.

Average demand in the WRZ was 19.8Ml/d in 2012/13; this includes supply from other sources within the WRZ including a spring source at Ffynnon Asaph and a number of pumped and artesian borehole sources in the Afon Clwyd catchment. Whilst the available resource from these sources may be somewhat reduced during drought conditions, and average zonal demand may be increased due to periods of high, dry weather demand, it would be unrealistic to plan for a scenario in which all of the drought year demand in the WRZ is met from the Aled and Plas Uchaf/Dolwen system alone. Average supply from Glascoed WTW in 2012/13 was 11.7Ml/d, 59% of the WRZ demand in that year. We have therefore assumed for the purposes of this assessment that demand in the WRZ is at the assessed deployable output level of

26Ml/d, and that just over 60% or 16Ml/d of this demand is required to be met from the Aled and Plas Uchaf/Dolwen system.

The hydrological impact on the reservoirs and river reaches considered in this assessment is therefore summarised as an additional 806Ml of water abstracted from the Aled and an additional 856Ml of water abstracted from the Plas Uchaf/Dolwen reservoirs during the period 8th November to 31st March, relative to a baseline drought scenario in which no abstraction would be permitted during this period due to licensed limits being reached. This is consistent with Welsh Water's modelling which has determined that the drought permit is most likely to be implemented during the period from November to March.

Llyn Aled Reservoir and Aled Isaf Reservoir

The impact on Llyn Aled Reservoir and Aled Isaf Reservoir due to the implementation of this drought permit is that an additional 806Ml of water must be supplied as regulation releases to the Afon Aled, should flows be low enough to require support of the downstream abstraction at Bryn Aled which would continue during the period 3rd February to 31st March inclusive. However, typically both reservoirs would be full or refilling at this time of year, so the additional regulation releases would only be required during periods of low winter flows and/or when overflows are not occurring from Aled Isaf Reservoir.

As a worst case scenario, regulation releases at an average rate of 13.8Ml/d may be required over a 58-day period from Aled Isaf Reservoir if both Llyn Aled and Aled Isaf Reservoirs are still below top water level at that time. Based on a review of historic reservoir storage levels, the lowest combined average rate of net refill of the two reservoirs was 15.3Ml/d, occurring during the refill period of 1995/96. This is slightly higher than the required additional regulation release rate during the 58-day period, so there would be no reduction in minimum reservoir levels relative to the baseline scenario. However, the additional regulation releases required under the drought permit may lead to an increase in the overall length of time that either or both reservoirs are below top water level, of up to about 53 days or 22% of the overall duration of reservoir drawdown. (Both Llyn Aled and Aled Isaf reservoirs were below top water level for approximately 245 days during the 1995/96 drought).

The hydrological impact of the drought permit on water levels in both Llyn Aled Reservoir and Aled Isaf Reservoir is therefore assessed to be **minor**.

Dolwen Reservoir

The impact of increasing the annual licence quantity on Plas Uchaf and Dolwen Reservoirs would be to allow daily abstraction to continue for a longer period of time. In the baseline scenario, abstraction from the Plas Uchaf and Dolwen system would cease on 8th November, and hence the estimated average dry year contribution of 2Ml/d would not be taken during the remaining 53-day period to the end of the year, theoretically allowing storage to recover by around 106Ml over that period. With the drought permit in place, the increased annual licence would allow this additional water to be abstracted, leaving Dolwen Reservoir with

106Ml less water in storage by 31st December than in the baseline scenario. This is equivalent to a reduction in the water level of around 1.7m or 11%.

The continuation of abstraction for a further 53 days relative to the baseline scenario could potentially lead to an increase of up to 53 days in the time for which Dolwen Reservoir is drawn down below top water level, depending on the pattern of inflows from 1st January onwards.

The hydrological impact of the drought permit on water levels in Dolwen Reservoir is therefore assessed to be **major**.

Plas Uchaf Reservoir

Plas Uchaf is generally used as a balancing reservoir, to hold water transferred from Dolwen Reservoir and/or Bryn Aled river intake on the Afon Aled, prior to supply to Glascoed WTW. As such it is assumed that Plas Uchaf would generally be kept full by topping it up from these two main sources of supply, however in severe drought conditions with high demands it is possible that some lowering of water levels may take place.

In the baseline scenario, abstraction from the Plas Uchaf and Dolwen system would cease from 8th November until the end of the calendar year, so there would be a chance for reservoir levels to recover following any drawdown. However, with the drought permit in place, abstraction from Plas Uchaf would continue for a further 53 days, potentially lowering water levels further or at least preventing them from recovering back to the normal level, depending on natural inflow rates which are more likely to increase above 2Ml/d later in the year.

The minimum simulated storage in Plas Uchaf Reservoir in Welsh Water's WRAPSim deployable output simulation for the Clwyd Coastal WRZ is 10.8% of live storage or approximately 23Ml (2/11/2007). There is little scope for water levels to fall much below this, but with the drought permit in place and abstractions continuing to be required to meet high demand, there is an increased likelihood that water levels may remain below top water level rather than recover by the end of the year. The relative difference in water levels by 31st December could potentially be as great as 3.5m or 23%, which represents the drawdown below top water level for the additional abstraction of 106Ml which is assumed to be met from the Plas Uchaf and Dolwen reservoir system natural inflows.

As Plas Uchaf Reservoir normally remains just below top water level in all but the most severe drought, the increased duration of the period below top water level, of up to 53 days with the drought permit in place, is likely to be significant.

The hydrological impact of the drought permit on water levels in Plas Uchaf Reservoir is therefore assessed to be **major**.

Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)

During the period from 1 February to 31 May inclusive, when the Bryn Aled intake is in operation, controlled releases from Aled Isaf Reservoir are made to maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake. These releases may be required if low flow conditions continue during winter months.

In the baseline drought scenario considered in this assessment, abstraction from the Aled ceases on 3rd February and therefore the release from Aled Isaf Reservoir will consist of the compensation release of 2.27Ml/d only after that date. With the drought permit in place, in which increased annual licences allow abstraction to continue from 3rd February to 31 March, regulation releases of between 9.2Ml/d to 16Ml/d would continue in low flow conditions to support downstream abstractions at the Bryn Aled intake. This increase in flows in reach 1, relative to the baseline drought scenario, would have a beneficial impact on flows in reach 1 during low flow periods and therefore the hydrological impact on reach 1 has been assessed as **minor beneficial** during the winter months of February and March.

Reach 2 – Afon Aled (Afon Deunant confluence to Bryn Aled intake)

The impacts of this drought option on Reach 2 are similar to those for Reach 1. Abstraction will cease under the baseline drought scenario between 3rd February and 31st March, and flow from Aled Isaf Reservoir will be restricted to compensation release only. During low flow periods there will be minor additional inflow from the catchment area and the one significant tributary (Afon Deunant).

With the drought permit in place, regulation releases of between 9.2Ml/d to 16Ml/d, from Aled Isaf Reservoir via Reach 1, would continue in low flow conditions to support downstream abstractions at the Bryn Aled intake. These would increase the flow in Reach 2 relative to the baseline drought scenario, and the hydrological impact on Reach 2 has therefore been assessed as **minor beneficial** during the autumn and early winter months.

Reach 3 – Afon Aled (Bryn Aled intake to Afon Elwy confluence)

In the baseline scenario, there is no abstraction from the Bryn Aled intake from 3rd February and 31st March once the annual licensed limit has been reached. Therefore, there is no significant drop in flows between the lower end of Reach 2 and the upper end of Reach 3 during this period.

With the drought permit in place, abstractions from Bryn Aled can continue up to the daily maximum pumping capacity of 16Ml/d. At times when measured flows at the Bryn Aled flow gauge are 29.5Ml/d or below, these abstractions are fully supported by regulation releases made from the Aled Isaf Reservoir upstream, on a "put-and-take" basis, and therefore there is no impact on low flows downstream of the intake. At higher flows, however, when regulation releases are not required, the impact of the drought permit will be a reduction in flow downstream of the intake by the amount of the daily abstraction, which could be up to 16Ml/d,

relative to the position in the baseline scenario. The ecology of the river flow regime in this period will be most sensitive to reductions in the year round moderate (Q_{50}) and low (Q_{95}) flows.

In upper Reach 3, measured flow data are available from the Bryn Aled flow gauge. From the long term flow record, the year round low flow value (Q_{95}) is approximately 14.4Ml/d, whilst the year round moderate flow value (Q_{50}) is 62.9Ml/d. As discussed above, there will be no reduction in the Q_{95} low flow value as it is below the Residual Flow limit of 29.5Ml/d below which abstractions must be supported by regulation releases from Aled Isaf Reservoir. However, a daily abstraction of up to 16Ml/d represents a reduction of 25.4% in the Q_{50} value.

The hydrological impact of the drought permit on Reach 3 during the period 3rd February and 31st March has therefore been assessed as **minor.**

The abstraction regime under the drought permit is more similar to the normal winter abstraction regime than the baseline drought scenario (although abstractions have been assumed to be higher than in the historic record, to simulate a scenario in which the annual licences would be insufficient to cover the required demand at Glascoed WTW). However, for consistency we have assessed the relative difference from a baseline drought scenario in which abstractions would have to cease in the winter months of February and March due to the licensed annual limits being reached.

Reach 4 – Unnamed Stream (Dolwen Reservoir Outflow to Plas Uchaf Reservoir)

There is no flow data available for the unnamed stream which links Dolwen Reservoir to Plas Uchaf Reservoir, and it is not known if this stream is used to transfer water to Plas Uchaf Reservoir to support supply to Glascoed WTW. In the absence of any other information, we have assumed that quantities taken for supply from Dolwen Reservoir will be transferred to Plas Uchaf Reservoir via this stream channel.

In the baseline scenario, any natural inflows into Dolwen Reservoir would be allowed to drain into Plas Uchaf Reservoir to improve water quality as much as possible. Under the drought permit an assumed contribution of 2Ml/d is taken from the Dolwen Reservoir system, so that the flows in the stream below the reservoir would effectively continue at a similar rate. Therefore the hydrological impact on reach 4 has been assessed as **none** during the autumn and early winter months.

Reach 5 – Unnamed Stream (Plas Uchaf Reservoir Outflow to Afon Elwy confluence)

Under the drought permit, any quantities transferred from Dolwen Reservoir to Plas Uchaf Reservoir will be required to support the continuing high demands at Glascoed WTW, and so there will not be any corresponding increase in storage at Plas Uchaf Reservoir or spills to the downstream catchment. Therefore there is **no** hydrological impact anticipated on the stream below Plas Uchaf Reservoir which flows into the Afon Elwy a short distance downstream.

B.2.2.3 Hydrological Impact Summary

The four Aled catchment reservoirs and their five downstream river reaches have been considered. There is potentially a **minor** impact of this drought permit on Llyn Aled and Aled Isaf reservoirs, and a **major** impact on Plas Uchaf and Dolwen reservoirs, depending on volumes in storage when the drought permit is implemented and rainfall patterns during the winter period. There is a **minor beneficial** impact on two of the five river reaches, due to the fact that flows will potentially be increased to support continuing abstractions which would otherwise have ceased under the baseline drought scenario, a **minor** impact on the Afon Aled downstream of the Bryn Aled intake at times when flows are high enough to not require abstractions to be supported by regulation releases, and **no** relative impact on Reach 4 downstream of Dolwen Reservoir or reach 5 downstream of Plas Uchaf Reservoir. The five impacted reaches are shown in **Table B2.9** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

Table B2.9 Hydrological Reaches identified in the Study Area – Winter Impact (November - March)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact
		Upstream	Downstream		Year round Q_{50}	Year round Q_{95}	
Llyn Aled Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor**
Aled Isaf Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor**
Dolwen Reservoir		n/a	n/a	n/a	n/a	n/a	**Major**
Plas Uchaf Reservoir		n/a	n/a	n/a	n/a	n/a	**Major**
1	Afon Aled	Aled Isaf Reservoir Outflow	Afon Deunant confluence	10.1km	n/a	n/a	**Minor beneficial**
2	Afon Aled	Afon Deunant confluence	Bryn Aled intake	3.0km	n/a	n/a	**Minor beneficial**
3	Afon Aled	Bryn Aled intake	Afon Elwy confluence	1.6km	25.4%	0%	**Minor**
4	Unnamed stream	Dolwen Reservoir Outflow	Plas Uchaf Reservoir inlet	0.5km	n/a	n/a	**None**
5	Unnamed stream	Plas Uchaf Reservoir Outflow	Afon Elwy confluence	1km	n/a	n/a	**None**

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

Reach 1 is the 10.1km stretch of the Afon Aled as it flows between Aled Isaf Reservoir and the confluence with Afon Deunant. There are two River Habitat Survey (RHS) sites present in Reach 1 (sites 432 and 6432). The channel planform in Reach 1 (sites 432 and 6432) varies from irregular meanders to sinuous, being formed in boulder clay and alluvium and underlain by early Silurian (Wenlock stage) lithology. The upper section of hydrological reach 1 is a steep channel in an upland gorge. Typical river channel width in this section is 8.0m to 9.5m. After 4km, the gradient eases and the channel meanders through a modest floodplain on the floor of a steeply incised valley. Typical river channel width in this section is 11m to 15m. The channel substrate is predominantly cobble with some gravel/pebble, although gravel/pebble is predominant in some sections of Reach 1. One vegetated bar was observed at RHS survey site 432 within Reach 1, no other in-channel depositional features were observed in the RHS surveys or using aerial imagery. Site 432, in upper hydrological reach 1 has an HMS of 70, due to poaching and the presence of a reinforced bank. Site 6432, in lower Reach 1, is pristine, with an HMS of 0. Reach 2 is the most modified reach with several reinforced banks, although HMS is still low at 90. The dominant land cover in the catchment area of the lower reach is improved or semi-improved grassland with trees continuously lining the river bank. A notable feature of the lower reach is the bedrock water fall and bedrock steps that form an impassable barrier to fish travelling upstream.

Reach 2 is the 3km stretch of the Afon Aled between the confluence with the Afon Deunant and the Bryn Aled intake. There is one RHS site is present in Reach 2 (site 3432). The channel in Reach 2 is recorded as being straight (site 3432) and is formed in boulder clay and underlain by late Silurian (Ludlow stage) lithology.

Bankfull width increases down the hydrological reaches, and varies from 8m (site 432) to 11m (site 3432) in Reach 2, while banktop height varies down the reach from 1.5m in upper Reach 1 (site 432) to 1m in Reach 2 (site 3432). Rippled flow is predominant through Reaches 1 and 3, and is expected to be similar in Reaches 4 and 5. Anthropogenic modification varies throughout Reaches 1 and 2, with Habitat Modification Scores (HMS) illustrating only slight modification.

Unfortunately, no RHS survey data is available for Reaches 3-5, and geomorphological information has been provided by extant aerial imagery.

Reach 3 is the 1.6km stretch of the Afon Aled as it flows between the Bryn Aled intake and the confluence with the Afon Elwy. The short lower reach is the same channel form as Reach 2. Channel-forming high river flows are not influenced by the Bryn Aled intake. There is, however, a significant step-change in low river flows during times of abstraction at the Bryn Aled intake, particularly when supported by regulation releases from Aled Isaf Reservoir. The channel in Reach 3 is slightly sinuous and is underlain by late Silurian lithologies, with superficial deposits of alluvium, river terrace deposits and till. As no substrate data is available

for Reach 3, the calibre of sediment is expected to be the same as upstream. Bankfull dimensions are not available for Reaches 3, 4 and 5.

Reach 4 is the short (<0.5km) stretch of the unnamed stream between Dolwen Reservoir outflow and the inlet to Plas Uchaf Reservoir. Reach 5 is the short (approx. 1km) stretch of the unnamed stream between Plas Uchaf Reservoir outflow and the confluence with the Afon Elwy. Reaches 4 and 5 are slightly sinuous and are underlain by similar geology to Reach 3. Substrate data are not available for hydrological reaches 4 and 5, however due to the upland location, similar calibre sediment to hydrological reaches 1 and 2 are expected. Channel banks are predominantly steep and composed of earth.

Bankside tree cover is continuous in the upper Reach 1, decreasing down the reach to semi-continuous at the end of Reaches 2 and 3. Due to the location of Reaches 4 and 5, which are near reservoirs, some management is expected, especially near the reservoir outflows.

B.3.2 Water Quality

This section sets out the baseline water quality and examines changes over time and with respect to river flows. Environmental pressures on river water quality (such as discharges from Sweage Treatment Works (STWs), which may cause increased deterioration in water quality with the drought permit in place, are discussed separately in Section B.3.3.

To support the assessment of potentially sensitive environmental features (see Appendix D), an understanding has been developed of the water quality of the rivers within the zone of influence of the drought permit, including trends over time and with respect to river flow. For WFD classification, the Environment Agency has set out[2] following UKTAG evidence[3] what pressures, including water quality pressures, each biological quality element is capable of responding to. For the purposes of assessment here, the supporting water quality parameters are set out: for fish and macroinvertebrates (where identified as sensitive features) as dissolved oxygen saturation and total ammonia concentration; and for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features) as soluble reactive phosphorus (SRP). Specifically, for macrophytes, if the hydrological impacts of drought permit implementation have been identified within the main macrophyte growing season (April to September), an assessment of SRP has been undertaken.

Potential impacts on other water quality parameters, such as temperature, have been considered where appropriate (e.g. temperature influences dissolved oxygen and if sufficient information is available on dissolved oxygen and is being reviewed it may not be necessary to undertake a separate temperature assessment). Where data are lacking, the assessment has been undertaken using professional judgement.

[2] Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011 Table 2
[3] UK Technical Advisory Group on the Water Framework Directive (2008) Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive December 2007 (alien species list updated – Oct 2008 and Nov 2008). Appendix 1

Ten years of NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact). On the Afon Aled within the extent of influence of the drought permit there are three NRW water quality sampling sites, 2 on Reach 1 (Aled Isaf Outflow to Afon Deunant confluence) and 1 on Reach 2 (Afon Deunant confluence to Bryn Aled intake) (**Table B3.1** and **Figure B1.1**). Data are available for these sites (2006 to 2015) and include measurements of a suite of parameters. No data is available for Reaches 3 (Bryn Aled intake to Afon Elwy confluence), 4 (Dolwen Reservoir Outflow to Plas Uchaf Reservoir inlet) or 5 (Plas Uchaf Reservoir Outflow to Afon Elwy confluence).

Where data is lacking the assessment has been undertaken using professional judgement. Values at the limit of detection were halved in line with standard NRW practice.

Table B3.1 Details of NRW Water Quality Sampling Points on the Afon Aled

Reach	Site Name	NRW Site Code	Grid reference	Location
1	Afon Aled d/s Llyn Aled Isaf	2666	SH9152059870	A quarter up the Afon Aled before confluence with Aled Deunant
	Afon Aled u/s Afon Deunant	2682	SH9559067380	On the Afon Aled just before the confluence with Deunant.
2	Afon Aled Pont yr Aled	2688	SH9552070450	Half way up the Afon Aled from the Aled Deunant confluence.

Llyn Aled

No monitoring data were available for Llyn Aled. On this basis the water quality assessment has been undertaken using professional judgement and assessment of previously.

While temperature and oxygen data is unavailable certain assumptions can be made. Other shallow lake assessments (Llyn Bodlyn, Llyn Alaw etc.) have highlighted a clear relationship between temperature, oxygen and reservoir level. As Llyn Aled is similarly classified as shallow it is likely the temperature and oxygen response to reservoir level would be similar. With reduced reservoir depth, temperature increases. This is most apparently during the summer months. While dissolved oxygen saturation follows the same trend this is to a lesser extent than temperature. It should be noted that Llyn Aled is a shallower waterbody than those previously assessed. Consequently, the water quality impact may be more significant.

Aled Isaf Reservoir; Dolwen Reservoir & Plas Uchaf Reservoir

No monitoring data were available for Aled Isaf Reservoir, Dolwen Reservoir or Plas Uchaf Reservoir. The assessment of these reservoir has been based upon the same assumptions made for Llyn Aled (above) in conjunction with their respective hydrological impacts.

Water Quality Summary

Assessment of risk to water quality as a result of the Aled drought permit is limited by the spatial and temporal extent of the data available.

Dissolved oxygen saturation in Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf Reservoirs is likely to reduce. However, given the timing of this drought plans implementation (winter), temperature increases and subsequent dissolved oxygen reductions will be naturally mitigated against. Consequently, the risk to dissolved oxygen saturation is considered **medium** in Dolwen and Plas Uchaf Reservoir and **low** in Llyn Aled and Aled Isaf.

A **low** risk to dissolved oxygen is anticipated in Reach 3 reducing to **negligible** in Reaches 1, 2, 4 and 5.

No risk to ammonia concentration is expected in any reach of this drought permit.

No soluble reactive phosphorus assessment has been undertaken for this drought permit as its implementation falls outside the peak macrophyte growth period.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

During a drought, abstractions put pressure on flow by removing water from rivers and groundwater aquifers and potentially exacerbating natural low flows. As a result of a drought order, there may be less water available in the zone of influence for licence holders to abstract, and any abstractions that do occur may reduce the amount of surface water available – affecting the wetted perimeter of the habitat, velocities within the wetted area and the ability to dilute any pollutants entering the system. For surface water abstractions, this includes consumptive abstraction and partially consumptive / non-consumptive abstraction – where some or all of the water is returned to the river locally after use, with the potential to reduce flow in the river if the discharge is downstream of the abstraction.

An overview of licensed surface water abstractions is given below based on information received from NRW (see **Table B3.2**). The risk to the surface water abstractions is **negligible** due to the effect of the drought permit on Reach 2 and **major** to the abstractions upstream of Aled Isaf Reservoir.

Table B3.2 Surface Water abstractions in Area of Influence of the Afon Aled drought permit

Licence Number	Use	Daily abstraction limit (Ml/d)	Location	
			NGR	Description
24/66/5/0007	Water supply	27.3	SH9670	Reach 2
24/66/5/0006	Water supply	25.9	SH9158	U/S Aled Isaf Reservoir
24/66/5/0005	Water supply	6.8	SH9258	U/S Aled Isaf Reservoir

B.3.3.2 Water Quality Pressures

Discharges put pressure on water quality during a drought as lower than normal river flows mean that there is less water available to dilute discharges such as final effluent from STWs. Discharges impacting the oxygen balance and ammonia concentration in the river reaches have been reviewed. Significant pressures (discharges of over 0.5Ml/d) are shown on **Figure B1.1**. Any discharges may be considered as beneficial to river flow but may also pose risks to water quality (noting that only abstractions are considered as flow pressures in the section above).

There is one STW at Llansannan Sewage Treatment Works discharging into the Afon Aled or tributaries (**Table B3.3**). Due to the size and location of this discharge it is considered of **negligible** risk.

Table B3.3 Summary of Water Quality Pressures

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 C (mg/l)	Zone of influence (<500m)	Consideration of water quality pressure (during baseline low flow conditions)
CM0096701	Housing development off Ffordd Gogor, Llansannan	SH9343065750	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	230	Negligible
CM0018901	Llansannan Sewage Treatment Works	SH9371066010	Not Specified	0.0849	Not Specified	Not Specified	60	25	Negligible
CM0194701	Llansannan Ddol - sso	SH9350065884	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	15	Negligible

B4 PHYSICAL ENVIRONMENT SUMMARY

Potential impacts on the physical environment associated with the Aled Annual Licences drought permit are summarised in **Table B4.1.**

Table B4.1 Summary of Potential Changes to the Physical Environment of the Impacted Reaches from Implementation of the Aled Annual Licences Drought Permit

Llyn Aled Reservoir	
Water levels in Llyn Aled Reservoir *Minor impacts during the period from February to March inclusive*	• No decrease in water levels, but an increase in the duration of the reservoir drawdown period of up to 53 days (22%)
Water Quality in Llyn Aled Reservoir *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Aled Isaf Reservoir	
Water levels in Aled Isaf Reservoir *Minor impacts during the period from February to March inclusive*	• No decrease in water levels, but an increase in the duration of the reservoir drawdown period of up to 53 days (22%)
Water Quality in Aled Isaf Reservoir *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Dolwen Reservoir	
Water levels in Dolwen Reservoir *Major impacts during the period November to December inclusive*	• Decrease in water levels of around 11% by the end of the year
Water Quality in Dolwen Reservoir *Medium risk during the period November to December inclusive*	• Medium risk to dissolved oxygen. No risk to ammonia.
Plas Uchaf Reservoir	
Water levels in Plas Uchaf Reservoir *Major impacts during the period November to December inclusive*	• Decrease in water levels of around 23% by the end of the year
Water Quality in Plas Uchaf Reservoir *Medium risk during the period November to December inclusive*	• Medium risk to dissolved oxygen. No risk to ammonia.
Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir	
River Flows in the River Aled *Minor beneficial impacts during the period from February to March inclusive*	• Continued regulation releases to support downstream abstractions during low flow periods would increase flows in Reach 1
Geomorphology *Negligible impacts during the period from February to March inclusive*	• Due to the minor beneficial hydrological impact of the reach, geomorphological variation due to the drought permit is not expected to go beyond the normal low flow drought regime.
Water Quality *Negligible risk during the period from February to March inclusive*	• Negligible risk to dissolved oxygen. No risk to ammonia.
Afon Aled (Reach 2) – downstream of Afon Deunant	
River Flows in the River Aled *Minor beneficial impacts during the period from February to March inclusive*	• Continued regulation releases to support downstream abstractions during low flow periods would increase flows in Reach 2
Geomorphology *Negligible impacts during the period from February to March inclusive*	• Due to the minor beneficial hydrological impact of the reach, geomorphological variation due to the drought permit is not expected to go beyond the normal low flow drought regime.
Water Quality in the Afon Aled *Negligible risk during the period from February to March inclusive*	• Negligible risk to dissolved oxygen. No risk to ammonia.

Afon Aled (Reach 3) – downstream of Bryn Aled	
Flows in the River Aled *Minor impacts during the period from February to March inclusive*	• Continued abstraction from Bryn Aled intake could reduce median (Q_{50}) flows by up to 25.4% in February to March, relative to the baseline scenario in which no abstraction is permitted after 3 February.
Geomorphology *Minor impacts during the period from February to March inclusive*	• Due to the moderate hydrological impact of the reach, geomorphological variation due to the drought permit is expected to be minor. The system is adapted to bedload calibre sediment, with little suspended sediment transported during drought conditions. Siltation is, therefore, unlikely and will be removed when high flows return. Further, due to the large bedload substrate and dominant rippled flow, during the implementation of the drought permit increased siltation is unlikely. Wetted widths and depths will be affected where bank slope are shallower.
Water Quality in the Afon Aled *Low risk during the period from February to March inclusive*	• Low risk to dissolved oxygen. No risk to ammonia.
Unnamed Stream (Reach 4) – downstream of Dolwen Reservoir	
Flows in the unnamed watercourse *No impacts*	• Flows between Dolwen Reservoir and Plas Uchaf Reservoir, from natural inflows, would continue in both the baseline scenario in which no abstraction from Plas Uchaf Reservoir is taking place, and the drought permit scenario.
Unnamed Stream (Reach 5) – downstream of Plas Uchaf Reservoir	
Flows in the unnamed watercourse *No impacts*	• Any additional inflow from Dolwen Reservoir under the drought permit (relative to baseline scenario) would be required for abstraction to support demands at Glascoed WTW, so there would be no increase to flows downstream of Plas Uchaf Reservoir.

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Aled Annual Licences drought permit. The assessment, as described in previous sections, has considered how the proposed drought permit may affect the environment in combination with the effects of existing licences and consents. In accordance with the DPG the assessment also considers the potential cumulative effects of Welsh Water implementing other drought permits / orders within a similar timeframe. The potential for options to act in combination is set out in **Table B5.1**.

Consideration has also been given to the potential for cumulative impacts of drought options implemented by neighbouring water companies (see **Table B5.1**). The assessment of the potential for cumulative impacts of Welsh Water's supply side and drought permit / order options with drought options listed in neighbouring water companies' drought plans has also been undertaken as part of the Strategic Environmental Assessment (SEA) of Welsh Water's Draft Statutory Drought Plan. The SEA was informed by the most recent information available on the neighbouring water companies' drought plans.

Table B5.1 Cumulative Impacts of the Aled Annual Licences Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the Clwyd Coastal WRZ / Aled catchment	8012-2 (Reduced regulation releases from Aled Isaf Reservoir) – The drought permit would help to conserve storage in Aled Isaf Reservoir by reducing regulation flows but this would also potentially reduce flows in the downstream Afon Aled. Positive in combination effects on Llyn Aled Reservoir, Aled Isaf Reservoir 2 are anticipated. Given the beneficial impacts of the Aled Annual Licences drought permit on reaches 1 & 2, no significant in combination effects are anticipated.	No
	8012-5 (Relax Llannerch boreholes annual licences) – This would enable increased abstraction from Llannerch boreholes thereby allowing Bryn Aled abstractions to be reduced and assisting with Aled Isaf Reservoir and Llyn Aled refill. This would potentially have positive impacts on water levels in the two reservoirs but flows in the Afon Aled would be reduced. It may reduce the time period for which the impact of the Aled annual licence increase occurs.	No
	8012-6 (Pumped transfer from Aled Isaf to Llyn Aled) – This option would only be implemented in the winter once Aled Isaf Reservoir has refilled. No in-combination effects are anticipated as the two drought options would not be occurring at the same time.	No
Natural Resources Wales - Drought options in the Aled catchment	No previous drought order applications have been made in the North Wales region.	No

APPENDIX C
ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGY

A.1 ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGIES

The assessments undertaken in the EARs will use available environmental data. The following methodologies detail the preferred approach to impact assessment for the sensitive receptors identified in the screening process.

However, in certain circumstances the supporting data on hydrological conditions, habitat availability and species occurrence may not be currently available. In these cases, other supporting data will be used, where available, and the assessment will be undertaken using expert judgement. An example may be where flow-induced river habitat for fish would ideally be defined through the total wetted area, depth and flow velocities to describe the habitat preferences of a species and its lifestages. Where these data are currently unavailable, the use of habitat walkover, RHS and / or aerial survey data may be used in combination with judgements on the hydrological change resulting from the drought option (e.g. reduction in river flows) to arrive at a statement on habitat reduction and consequent impact on the fish species. The analysis will detail the increased uncertainty prevalent in the approach and will therefore adopt a precautionary approach to impact prediction (possibly assigning a higher impact where fewer substantiating data are available).

The gaps in data and evidence will be noted and monitoring proposals established.

Assessment sheets are included for the following features:

- Flow pressures
- Water quality pressures.
- WFD Status: Fish
- WFD Status: Aquatic macroinvertebrates
- Environment (Wales) Act Section 7 species, designated sites and other sensitive fauna and flora.

FLOW PRESSURES

Potential Effects
In support of understanding the physical environment and the risk assessment in the zone of influence of each drought option, a review will be undertaken of additional flow pressures from licensed surface water and groundwater abstractions. Relevant pressures have been identified and risk assessed in terms of in-combination flow impacts from implementation of a drought option. Abstractions have the potential to exacerbate low river flows or, in the case of groundwater-dominated catchments where rivers seasonally run dry (ephemeral watercourses), to increase the length of river that is dry and the period of time for which it remains so, potentially beyond the period for which the drought option is in place. As a result of a drought option, there may be less water available in the zone of influence (rivers and groundwater bodies) for licence holders to abstract, and any abstractions that do occur reduce the amount of surface water available – affecting the wetted perimeter of the habitat, velocities within the wetted area and the ability to dilute any pollutants entering the system. For surface water abstractions, this includes consumptive abstraction and partially consumptive/non-consumptive abstraction – where some or all of the water is returned to the river locally after use, with the potential to reduce flow in the river if the discharge is downstream of the abstraction.
Definition of Risk
Continuously flowing watercourses In order to define the potential risk to flow from river and groundwater abstractions in a readily understandable manner, a series of criteria have been defined. The assessment is informed by long term gauged flow data. The impact of the drought option will be considered against baseline 'drought' conditions (without drought option implementation). The assessment will use the following criteria, based on the potential severity of the risk to river water quality and flow during an ongoing drought. • High: A major reduction in low river flows, including the influence of the drought option - typically >25% reduction in summer Q95 (with drought option in place) • Medium: A moderate risk to low river flows (as above) , including the influence of the drought option - typically 10-25% reduction in summer Q95 (with drought option in place) • Low: A minor risk to low river flows, including the influence of the drought option - typically <10% reduction in summer Q95 (with drought option in place) • Negligible: Indicative of no significant change from the "without drought" option baseline situation. **Ephemeral watercourses** In line with the methodology for hydrology, an alternative approach to risk is required for

watercourses that naturally dry for part of the year that are potentially impacted upon by the drought option. Such watercourses are identified from previous investigations and available data. The assessment will use the following criteria, based on the potential severity of the risk to river water quality and flow during an ongoing drought.

- High: If the abstraction resulted in sections drying (with drought option in place) that would not (without drought option in place)
- Medium: If the abstraction resulted in sections drying earlier (by more than a handful of days) and/or returning to flow later (by more than a handful of days) and hence flow reduction occurring in the channel for more than just a handful of days (with drought option in place)
- Low: If the abstraction resulted in sections drying earlier (by just a handful of days) and/or returning to flow later (by just a handful of days) and hence flow reduction occurring in the channel for more than just a handful of days OR if the abstraction were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought permit) (with abstraction in place)
- Negligible: Indicative of no significant change from the "without drought" option baseline situation.

Data Requirements

- Relevant zone of influence (as identified from screening)
- Surface water and groundwater abstraction licences in the zone of influence
- River flow representative of the zone of influence (daily gauged flow and spot flow surveys) – all available records
- Flow predictions and zones of hydrological impact for each drought option.

Assessment Methodology and Uncertainty

1. Identify relevant abstraction licences within the zone of hydrological impact for the drought option: both groundwater abstractions from the aquifer(s) impacted by the drought option (confined and unconfined) and surface water abstractions from the impacted river reaches.

Groundwater abstractions

2. For groundwater abstractions, identify which aquifer they abstract from and key characteristics of the aquifer (confined/unconfined) if available. List relevant details from each abstraction licence including licence number, holder, use, depth abstracted from and maximum daily abstraction rate.
3. Use depths of abstraction to identify which of these abstractions are likely to be affected by reduced groundwater levels in the aquifer with the drought option in place. If depth information is not available, take a precautionary approach and assume all abstractions within the relevant area (or, if known, from the relevant aquifer) are affected.
4. Calculate the maximum volume of groundwater abstractions from each aquifer at low flows (i.e. the sum of abstractions of sufficient depth from the aquifer) with a drought option in place.

5. Use expert judgement to assess the in-combination significance of these groundwater abstractions on river flows in impacted reaches (both continuously flowing and ephemeral watercourses), based on known (measured or modelled) relationships between groundwater levels and river flows in that area and the definition of risk set out above.

Surface water abstractions – continuously flowing watercourses

6. Assign relevant abstraction licences to an impacted river reach, and list relevant details from the licence including licence number, holder, use, type (consumptive or non-consumptive), location (mainstem or tributary) and daily maximum abstraction rate (including any Hands-Off Flow restrictions). Identify which of these abstractions are likely to be affected by reduced water levels in the river with the drought option in place.
7. Calculate the maximum volume of surface water abstractions in each reach at low flows (i.e. the sum of consumptive, unrestricted abstractions on the main stem of the river) as a proportion of summer Q95 river flow with a drought option in place.
8. Assess the in-combination significance of these pressures on river flow with respect to hydrological assessment methodologies described in Section 2.2.2 of the main report.
9. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.

Surface water abstractions – ephemeral watercourses

10. Assign relevant abstraction licences to an impacted river reach, and list relevant details from the licence including licence number, holder, use, type (consumptive or non-consumptive), location (mainstem or tributary) and daily abstraction maximum (including any Hands-Off Flow restrictions). Identify which of these abstractions are likely to be affected by reduced water levels in the river with the drought option in place.
11. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.

All abstractions

12. For both groundwater and surface water abstractions, incorporate any flow pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

WATER QUALITY PRESSURES

Potential Effects

In support of the physical environment understanding and risk assessment in the zone of influence of each drought option, a review will be undertaken of additional water quality pressures from consented surface water discharges. Discharges put pressure on water quality during a drought as lower than normal river flows mean that there is less water available to dilute discharges such as final effluent from STW. A drought option may exacerbate these low flows and contribute to a reduction in water quality, with potentially detrimental impacts on sensitive features in the impacted reach. Discharges impacting the oxygen balance and ammonia concentration (to support fish and macroinvertebrates, where these are identified as sensitive features) and soluble reactive phosphorus (SRP) concentration (to support macrophytes and algae, where these are identified as sensitive features) in the river have been reviewed.

Intermittent discharges from combined sewer overflows (CSOs) may also contribute to a reduction in water quality during an environmental drought. CSOs relieve strain on the sewers during storm events by temporarily diverting water into nearby watercourses to prevent sewer flooding. As there is usually a time lag between discharges from CSOs and rises in river levels during a storm event, the potential exacerbation of low flows by the drought option may decrease the amount of water immediately available to dilute CSO discharges, leading to a temporary reduction in river water quality if a storm event occurs during implementation of the drought option.

Definition of Risk

Continuously flowing watercourses

In order to define the potential risk to water quality from discharges into the river in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the risk to water quality during an ongoing drought.

- High: A major risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); and exacerbation of the risk by the flow reduction from the drought option
- Medium: A moderate risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation of a minor risk by the flow reduction from the drought option
- Low: A minor risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation to a minor risk by the flow reduction from the drought option
- Negligible: Indicative of no significant risk without the drought option nor exacerbation of risk by the flow reduction from the drought option

Ephemeral watercourses

In line with the methodology for hydrology, an alternative approach to risk is required for

watercourses that naturally dry for part of the year that are potentially impacted upon by the drought option. Such watercourses are identified from previous investigations and available data. The assessment will use the following criteria, based on the potential severity of the risk to river water quality during an ongoing drought.

- High: A major risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); and exacerbation of the risk if the drought option resulted in sections drying (with drought option in place) that would not (without drought option in place)
- Medium: A moderate risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation of a minor risk by the flow reduction from the drought option occurring in the channel for more than just a handful of days.
- Low: A minor risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation to a minor risk by the flow reduction from the drought option occurring in the channel for just a handful of days.
- Negligible: Indicative of no significant risk without the drought option nor exacerbation of risk by the flow reduction from the drought option

Data Requirements

- Relevant zone of influence (as identified from screening)
- Surface water discharge consents in the zone of influence (including numeric water quality and flow conditions)
- Routine NRW / Environment Agency riverine water quality monitoring data for the water quality determinands dissolved oxygen saturation, SRP concentration and total ammonia concentration for relevant monitoring sites in the zone of influence and significant tributaries
- River flow representative of the zone of influence (daily gauged flow and spot flow surveys) – all available records
- Flow predictions and zones of hydrological impact for each drought option
- CSO locations and previous assessments of intermittent discharges from Welsh Water.

Assessment Methodology and Uncertainty

1. Identify sensitive features (fish, macroinvertebrates, macrophytes and algae) which may be impacted by the drought option. Use this information to determine whether assessment of oxygen balance, ammonia concentration and/or SRP concentration is required.
2. Identify all discharge consents within the zone of hydrological impact for the drought option.
3. Assign relevant discharge consents to an impacted reach, and list relevant details from the consent including consent number, holder, use, location (mainstem or tributary) and relevant numeric

consent conditions (Dry Weather Flow, BOD, ammonia (N), total phosphorous)[1].

4. Identify those discharge consents which relate to effluent from Welsh Water's sewage treatment works (STWs).

Continuously flowing watercourses

5. Model the maximum current contribution of each STW to BOD, ammonia (N) and total phosphorous concentrations (as relevant) in the river at low flows (based on the water quality consents, DWF and upstream flows).
6. Model the maximum potential increase in each STW's contribution to river BOD, ammonia (N) and total phosphorous concentrations (as relevant) at low flows as a result of the drought option (based on the water quality consents, DWF, upstream flows and maximum flow reduction from drought option).
7. Assess the potential risk that the STW could pose to river ammonia quality (using the consented discharge condition total ammonia) using modelled data and the appropriate matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to ammonia concentrations at low flows [a]	<0.2mgN/l	Minor	Moderate
	≥0.2mgN/l	Moderate	Major

[a] Standards are WFD high/good threshold for ammonia (N) of 0.2mg/l for upland low alkalinity rivers[2].

Lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to ammonia concentrations at low flows [b]	<0.3mgN/l	Minor	Moderate
	≥0.3mgN/l	Moderate	Major

[b] Standards are WFD high/good threshold for ammonia (N) of 0.3mg/l for lowland high alkalinity rivers[3].

8. Assess the potential risk that the STW could pose to river oxygen balance (using the consented discharge condition BOD) using modelled data and the matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to BOD concentrations at low flows [c]	<1mg/l	Minor	Minor
	1-3mg/	Minor	Moderate
	≥3mg/l	Moderate	Major

[c] Standards are WFD high/good threshold for BOD of 3mg/l and good/moderate threshold of 4mg/l for upland low alkalinity rivers[4].

Lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to BOD concentrations at low flows [d]	<1mg/l	Minor	Minor
	1-4mg/	Minor	Moderate
	≥4mg/l	Moderate	Major

[d] Standards are WFD high/good threshold for BOD of 4mg/l and good/moderate threshold of 5mg/l for lowland high

[1] Note that not all STWs have water quality consents relating to ammonia or total phosphorous (depends on size and location of STW). Consents are set with respect to total phosphorous rather than SRP.

[2] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

[3] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

[4] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

alkalinity rivers[5].

9. Assess the potential risk that the STW could pose to river phosphorous quality (using the consented discharge condition total phosphorous) using modelled data and the matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option. Consents are set with respect to total phosphorous rather than SRP (on which WFD river standards are based), therefore this approach conservatively assumes that all phosphorous from STWs is reactive and has direct implications for ecology in the river.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to ammonia concentrations at low flows [e]	<0.2mgN/l	Minor	Moderate
	≥0.2mgN/l	Moderate	Major

[e] Standards are WFD high/good threshold for SRP of 0.02mg/l and good/moderate threshold of 0.04mg/l for upland low alkalinity rivers[6].

Lowland low alkalinity river[7]		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to ammonia concentrations at low flows [f]	<0.03mgN/l	Minor	Moderate
	≥0.03mgN/l	Moderate	Major

[f] Standards are WFD high/good threshold for SRP of 0.03mg/l and good/moderate threshold of 0.05mg/l for lowland low alkalinity rivers[8].

Upland/ lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		<20%	≥20%
Current contribution to ammonia concentrations at low flows [g]	<0.05mgP/l	Minor	Moderate
	≥0.05mgP/l	Moderate	Major

[g] Standards are WFD high/good threshold for SRP of 0.05mg/l and good/moderate threshold of 0.12mg/l for upland/ lowland high alkalinity rivers[9].

10. Identify those discharges which relate to effluent from Welsh Water's combined sewer overflows (CSOs).
11. If required, carry out qualitative analysis using previous assessments of intermittent discharges to evaluate whether any CSOs are likely to present a significant water quality pressure as a result of the drought option.
12. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.
13. Incorporate any water quality pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

Ephemeral watercourses

14. Calculate the maximum concentrations of BOD, ammonia (N) and SRP (as relevant) in the final effluent of each STW under consented conditions (i.e. concentrations in the river with no natural dilution).

[5] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

[6] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

[7] Note that "Lowland low alkalinity" is a category that only exisits for SRP standards, and not for total ammonia or BOD.

[8] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

[9] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

15. Identify those discharges which relate to effluent from Welsh Water's combined sewer overflows (CSOs).
16. If required, carry out qualitative analysis using previous assessments of intermittent discharges to evaluate whether any CSOs are likely to present a significant water quality pressure as a result of the drought option.
17. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.
18. Incorporate any water quality pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

WATER FRAMEWORK DIRECTIVE STATUS: FISH

Potential Effects
For WFD river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the fish element of biological status is *High* or *Good*, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the *Good* status band to the *Moderate* status band, as advised by NRW / Environment Agency.
Definition of Impacts
In order to define the potential WFD status impacts for fish in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought. • Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the fish biological element of the classification. • Moderate: A moderate impact on fish status occurs when the fish population is predicted to be materially influenced, including effects on density, abundance or community composition, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the populations. • Minor: A minor impact occurs when there is a predicted impact on fish abundance, density or community composition that is within the usual variability for the site and which will recover within a short timescale. • Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the fish population.
Data Requirements
Fish status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Fish data should include species presence, abundance and density. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) as follows: • Relevant study area (as identified in the screening report) • Hydrology at or close to the monitoring sites to link to fish data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records • Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges • Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys • Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.

Assessment Methodology and Uncertainty

The WFD classification for the waterbody will be identified and the reasons for classification established from the NRW / Environment Agency. The data used to support the assessment will be reviewed to ensure that the classification is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These will include graphing the hydrology, water quality, habitat and fish variation temporally over the monitored period.

The analysis will consider the relationship between fish status and the supporting environmental variables over the period, with an emphasis on changes to fish status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether fish status responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought option may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option. This will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth.

Once the flow, habitat and water quality drought option predictions have been established, their implications for existing fish species will be assessed. The flow and habitat environmental envelope of the key fish species is known. The predicted changes in supporting environmental variables (flow, depth, velocity, habitat quality, dissolved oxygen levels and temperature) due to the drought option will be assessed against the fish population data. Where the supporting environmental variables for fish species are modified to take them outside of their preferred envelope it can be assumed that there will be a moderate or major impact on that fish population. Consideration will be given to the potential for density dependent mortality where data show that the fish population has an existing good density, and where the drought option reduces habitat availability significantly The assessment will consider the scale and longevity of any fish status impacts. The WFD classification is calculated on a 3 year rolling basis. A deterioration in classification would require a long term (2+ breeding seasons) and significant effect on fish population structure to allow prediction of a deterioration in status.

Where data are not available the assessment will be undertaken using expert judgement and drawing on broad-scale evidence from other similar catchments if applicable.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or

surveillance data are used for impact assessment purposes. Lastly the environmental envelopes within which fish species can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study will therefore adopt a precautionary approach, with potential impact highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, should an option be enacted, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the fish populations.

WATER FRAMEWORK DIRECTIVE STATUS: MACROINVERTEBRATES

Potential Effects
For Water Framework Directive (WFD) river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the aquatic macroinvertebrate component of ecological status is *High* or *Good*, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the *Good* status band to the *Moderate* status band.
Definition of Impacts
In order to define the potential WFD status impacts for aquatic macroinvertebrates in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought. • Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the macroinvertebrate biological element of the classification. • Moderate: A moderate impact on macroinvertebrate status occurs when the macroinvertebrate community is predicted to be materially influenced, including reduction in the LIFE score, or in community density +/or abundance, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the community. • Minor: A minor impact occurs when there is a predicted impact on macroinvertebrate abundance, density or composition that is within the usual variability for the site and which will recover within a short timescale. • Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the macroinvertebrate community.
Data Requirements
The baseline for macroinvertebrates will be established from existing data together with a comparison of species flow preference and taxon abundance. The analysis will provide an assessment of the community type and its sensitivity. Macroinvertebrate status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Macroinvertebrate data should include the LIFE and BMWP scores, together with abundance and density data where available. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) and other environmental variables as follows: • Relevant study area (as identified by screening) • Hydrology at or close to the monitoring sites to link to macroinvertebrate data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records • Meteorology (where flow data insufficient) from available NRW / Environment Agency

rain gauges

- Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys, to calculate HQA / HMS.
- Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.

Assessment Methodology and Uncertainty

Having established the baseline, the relative changes expected as a result of the drought actions (in relation to normal drought conditions) in river hydrology, geomorphology and water quality will be identified (see WFD fish assessment). An assessment will then been made of the habitat requirements of the key riverine macroinvertebrate communities present, using existing knowledge of their range of preferences. Depending on the resolution of baseline data available, detailed statistical analysis of the datasets may be possible. However, in some cases, where relatively limited spatial and/or temporal datasets are available, the impact assessment of the drought actions will be based on qualified expert judgement of the potential effects of the predicted changes in the environmental variables on the macroinvertebrate communities. The analysis is supplemented by consideration of the implications of environmental change on the key macroinvertebrate metrics, including LIFE scores.

The WFD macroinvertebrate classification for the water body will be identified and the reasons for classification established from the NRW / Environment Agency. The data used to support the assessment will be analysed to ensure that the classification is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These will include graphing the hydrology, water quality, and macroinvertebrate (ASPT and LIFE scores) variation temporally over the monitored period.

The analysis will consider the relationship between macroinvertebrate status and the supporting environmental variables over the period, with an emphasis on changes to status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether status responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought option may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option. This will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth. These data may have been developed for the WFD fish status assessment and duplication of effort will be avoided.

Once the flow, habitat and water quality drought option predictions have been established, their implications for the existing macroinvertebrate community will be assessed. The linkage between flow and habitat environmental envelope for upland macroinvertebrate communities is subject to continuing debate but has been shown to be linked (see for example, Dunbar et al 2009; 2010). The predicted changes in supporting environmental variables (flow, habitat quality) due to the drought option should be assessed against the macroinvertebrate community LIFE scores. Consideration will be given to the relationships between flow, habitat and LIFE scores in the DRIED-UP research papers. The predicted relative change in Q_{95} low flow value for the drought option should be compared to the Q_{95}/reduction in LIFE score; HQA/reduction in LIFE score in Dunbar *et al* 2010 to develop an approximation of the scale of change in macroinvertebrate community that could be expected.

The assessment will consider the scale and longevity of any macroinvertebrate community impacts. The WFD classification is calculated on a 3 year rolling basis. A deterioration in classification would require a long term and significant effect on macroinvertebrate community structure to establish prediction of a deterioration in status.

Where data are not available the assessment will be undertaken using expert judgement and drawing on broad-scale evidence from other similar catchments within the reservoir group.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or surveillance data are used for impact assessment purposes. Lastly the environmental envelopes within which the macroinvertebrate community can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. For macroinvertebrates the evidence base for the prediction of flows and changes to LIFE score remain subject to significant debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study should therefore adopt a precautionary approach, with potential impact highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, should an option be enacted, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the macroinvertebrate community.

NOTABLE SPECIES, DESIGNATED SITES AND OTHER SENSITIVE FAUNA AND FLORA

Potential Effects

Where screening of the drought option has identified that a notable species or designated site is present within the zone of influence of the drought option and screening has indicated that it is sensitive to the impacts of the drought option, the potential impact is to be investigated. Notable species are defined as Environment (Wales) Act Section 7 species or species with significant ecological sensitivity in the specified locality including species listed on IUCN red list and those not included in the red list which are nonetheless uncommon. This investigation will consider the habitat preferences of the species and its lifestages (if appropriate) and the impacts of the variation in flow (and consequent physical habitat and ecosystem) on these preferences. Potential effects are associated either 1) directly to a reduction in river flow; or 2) a reduction in water quality; 3) secondary effects of reduced velocity, for example on sediment characteristics.

Definition of Impacts

In order to define the potential impacts for sensitive ecological features in a readily understandable manner, a series of criteria have been defined. The significance of impacts upon the sensitive ecological feature will be identified following the Institute of Ecology and Environmental Managements (CIEEM) Ecological Impact Assessment (EcIA) guidance[10]. The potential significance of the impacts is identified using the following:

- **Value of the Ecological Receptor** – each ecological receptor is attributed a geographic value based upon its legislative and conservation status, as identified in Table 1.

Table 1 Value of Ecological Receptor

Ecological Value	Example
International	Existing or warranting designation as a e.g SPA and/or of significant conservation status for Europe (e.g European Protected Species (EPS)).
National	Existing or warranting designation as a SSSI and/or of significant conservation status for England (i.e. identified as a NERC / Environment Act (Wales) Section 7 species).
Regional	Habitats or species valuable at a regional level and/or of significant conservation status for the region (e.g viable breeding populations of Nationally Scarce species).
County	For example, existing or warranting designation as a County Wildlife Site (CWS) and/or of significant conservation status for the county (e.g viable breeding populations of species of county/metropolitan rarities).
District	For example, habitats or species of significant conservation status for the district (e.g viable breeding populations of species listed as rare in the district or borough).
Parish (local)	Species whose presence is considered to appreciably enrich biodiversity within the context of the parish or local neighbourhood, including as a local recreational/educational resource.
Site (within zone of influence only)	Species which are so low grade or widespread so as to be considered as not contributing to biodiversity value outside the boundaries of the site.

- **Positive or Negative Impact** – all impacts are considered to be negative unless

[10] CIEEM (2018) *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine.* Chartered Institute of Ecology and Environmental Management, Winchester.

otherwise stated in the feature assessment.

- **Extent** – the extent of the impact is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified using the criteria identified in **Table 2**

Table 2 Magnitude of Impact

Impact Magnitude	Description
High	There is a long-term large-scale (i.e. catchment) change in the ecological receptor and/or changes in the overall integrity of the ecological receptor.
Medium	There is a short-term large-scale change or long-term short-scale (i.e. reach) change in the ecological receptor, however no changes in the overall integrity of the ecological receptor.
Low	There is a short-term small-scale change in the ecological receptor, but its overall integrity is not impacted.
Negligible	No perceptible change in the ecological receptor.

- **Duration** – the duration of impact is considered to be for 6 months, which is the duration for which a drought option is implemented, unless otherwise stated.
- **Reversibility** – all impacts are considered to be reversible unless they are identified to have a likely impact upon the overall integrity of the ecological receptor.
- **Timing and Frequency** – the drought option could be implemented at any point in the year, however the different life stages of the sensitive ecological features will be taken into account. The assessment is based upon the operation of a single drought permit, with subsequent applications for a drought permit required to consider cumulative effects of multiple drought permits.
- **Probability** – all impacts are considered to be probable, unless otherwise stated.

Once the value of the ecological receptor, magnitude of impacts and other parameters listed above have been identified, these are used to inform the assessment of significance of impact on the ecological receptor.

Data Requirements

Sensitive ecological features baseline review requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Data should include species presence, abundance and density. It is likely that most fisheries data will be for O and O+ lifestages, with some indication of older echelons. Environmental supporting data should include habitat availability, hydrology and water quality as follows:

- Relevant study area (as identified in the screening report)
- Hydrology at or close to the monitoring sites to link to fish data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records

- Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges
- Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys
- Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area
- Habitat preferences for the given sensitive ecological features will be described, against which habitat change can be assessed.

Assessment Methodology and Uncertainty

The NERC / Environment (Wales) Act Section 7 species status for the watercourses will be identified and the reasons for its inclusion in the NERC / Environment (Wales) Act Section 7 established from the relevant bodies (start with NRW / Environment Agency). The data used to support the Environment (Wales) Act Section 7 assessment will be reviewed to ensure that it is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These should include graphing the hydrology, water quality, habitat and fish variation temporally and, if multiple sites, spatially over the monitored period. The analysis will consider the relationship between sensitive ecological feature lifestages and the supporting environmental variables over the period, with an emphasis on changes to status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether the sensitive ecological features population responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought permit may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option conditions. Ideally this will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth. In many cases these data are currently unlikely to exist and proxy measures such as RHS and/or aerial survey data will be used.

Once the flow, habitat and water quality drought option predictions have been established, their implications for the sensitive ecological features will be assessed. The flow and habitat environmental preferences of the sensitive ecological features will be described. The predicted changes in supporting environmental variables (flow, depth, velocity, habitat quality, dissolved oxygen levels and/or temperature) due to the drought option should be assessed against the sensitive ecological features population data.

Where data are not available the assessment will be undertaken using expert judgement and

drawing on broad-scale evidence from other similar catchments.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or surveillance data are used for impact assessment purposes. Lastly the environmental preferences within which species can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study will therefore adopt a precautionary approach, with potential impacts highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the sensitive ecological features populations.

Habitat Preferences

Habitat Preferences		**Unfavourable Habitat**	**Potential Impacts**
Type/ Age Class	**Description**		
Atlantic salmon *Salmo salar* and Brown/Sea trout *Salmo trutta*			
Spawning	• Clean and unconsolidated gravels typically in the transitional area between pools and riffles where the flow is accelerating and depth is decreasing	-	Deposition of silt
			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
Nursery (fry and parr life stage)	• Shallow areas with a low water velocity and pebble substrate, often at the margins of riffles	• Deep and/or high velocity habitats.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	Deep habitats that provide shelter including one or more of the following: • submerged structures • undercut banks • overhanging vegetation <50cm above the water surface • water surface turbulence causing a broken surface • Deep pools downstream of obstacles and sufficient water quantity through structures to enable passage across obstacles.	• Open and shallow habitats, but will use these during migration to reach spawning gravels. • Habitats upstream of significant obstructions.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Increased significance of barriers to impede migration as a result of decreased flows
			Deterioration in water quality
Brook lamprey *Lampetra planeri*			
Spawning	• Clean, unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.	- -	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	• Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. • Variation in depth between 2cm and 30cm (>15cm is optimal) with a relatively high organic content.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	**Description**		
			Deterioration in water quality
Adults	• Cover (stones and vegetation) in the vicinity of spawning gravels.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
River lamprey *Lampetra fluviatilis*			
Spawning	• Clean and unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.	-	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	• Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2cm and 30cm (>15cm is optimal) with a relatively high organic content.	-	Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	• Suitable estuarine conditions, that is free from pollution and with suitable prey species available. • Clear migration routes from the estuary to spawning grounds with suitable river flows and no barriers.	• Areas with significant pollution or limited prey availability. • Habitats upstream of significant obstructions.	Increased significance of barriers to impede migration as a result of decreased flows
			Increased risk of entrainment into water intake
			Deterioration in water quality
Sea lamprey, *Petromyzon marinus*			
Spawning	• Clean and unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.	-	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	• Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2cm and 30cm (>15cm is optimal) with a relatively high organic content.	-	Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	• Suitable estuarine conditions, that is free from pollution and with suitable prey species available. • Clear migration routes from the estuary to spawning grounds with suitable river flows and no barriers.	• Areas with significant pollution or limited prey availability. • Habitats upstream of significant obstructions.	Increased significance of barriers to impede migration as a result of decreased flows
			Increased risk of entrainment into water intake
			Deterioration in water quality
Bullhead, *Cottus gobio*			
Spawning	• Coarse, hard substrate of gravel and stones.	• Deep, silty watercourses with high flow velocities and little or no cover.	Deposition of silt
			Reduction in velocity, depth and/or wetted width
			Increased water velocity and depth

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	**Description**		
Nursery	• Shallow, stony riffles		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adult	• Sheltered sections created by woody debris, tree roots, leaf litter, macrophyte cover or larger stones.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
European eel, *Anguilla anguilla*			
Juvenile (<30cm)	• Wetland habitats within 30km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.	• Low productivity watercourses with dominance of coarse substrates and low macrophyte cover and diversity. • Habitats upstream of significant obstructions.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adult (>30cm, female >45cm)	• Deep, slow flowing watercourses and wetland habitats within 80km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased significance of barriers to impede migration as a result of decreased flows
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Barbel *Barbus barbus*			
Spawning	• Run/glide flow • Less than 50cm deep • Velocities greater than 0.5m/s • Substrate composed of clean and uncompacted gravel	-	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	• Marginal shallow bays set back from or within margins of main channel • Depths between 1cm and 30cm • No discernible to minimal flow • Substrate composed of >30% gravel and sand with low silt content • Lack of or very little riparian shading		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	• Commonly associated with stretches of clean gravel and macrophyte beds, showing a preference to relatively fast-flowing stretches in the middle reaches of larger rivers. • The species also occupies deep water habitats at the foot of weirs,		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Impedance to movement upstream
			Increased water velocity and depth
			Increased risk of entrainment into water intake

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	**Description**		
	in the lee of large woody debris, rock ledges or other obstructions on the river bed.		Deterioration in water quality
			Increased water velocity and depth
Fine-lined pea mussel, *Pisidium tenuilineatum* and depressed river mussel *Pseudanodonta complanata*			
All life stages	• Fine sediments of lowland rivers and canals,	• High velocity watercourses with coarse substrates.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
White-clawed crayfish *Austropotamobius pallipes*			
All life stages	• Slow-flowing sections of stony rivers • Boulder riffles in chalk or clay streams • Submerged tree roots • Debris dams • Crevices in old or damaged submerged brickwork, stonework, cracked concrete or rotten wooden structures • Un-mortared stone revetting which protects banks from erosion • Stands of submerged and emergent aquatic plants • Old gravel workings and chalk pits • Good water quality	• Uniform clay channels • Areas of deep or soft silt • Dense filamentous algae • Narrow fast-flowing channels • Areas of sand and gravel, or bedrock, which are lacking in cobble or boulder (though they may feed in or commute through these areas) • Pebble or cobble shingle regularly exposed by changing river levels • Areas of armoured bed where the substrate is compacted by the river flow • Acidic streams or ochreous drainage • Poor water quality or salinity	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Transfer of non-native species or disease
			Deterioration in water quality

APPENDIX D
ENVIRONMENTAL FEATURES ASSESSMENT

D1 INTRODUCTION

This appendix presents information regarding the environmental features associated with the Aled Annual drought permit. Baseline data and the impact assessments are presented for the environmental features that form part of the scope of the assessment (established by the screening exercise described in Section 3.2.2 of the EAR and results of which are summarised in Section 5.2). The features assessment presented in full below is summarised in Section 5.3 of the EAR.

Points of interest referred to throughout the text in Section 5 are indicated in **Figure D1.1**.

The approach to the assessment addresses the following: i) potential effects on each sensitive receptor; ii) definitions for impacts (adverse / beneficial), i.e. the significance criteria (quantitative and / or qualitative measures used to grade the severity of impacts of the drought order for the impact criteria major, moderate, minor, negligible; following the requirements of the DPG); iii) the data requirements; iv) assessment methodology (including the treatment of uncertainty where the complete data requirements are not available).

The assessment of environmental features is informed by the assessment of the physical environment (which includes hydrology and hydrodynamics; geomorphology; and water quality), this is summarised in Section 4 presented in full in **Appendix B**.

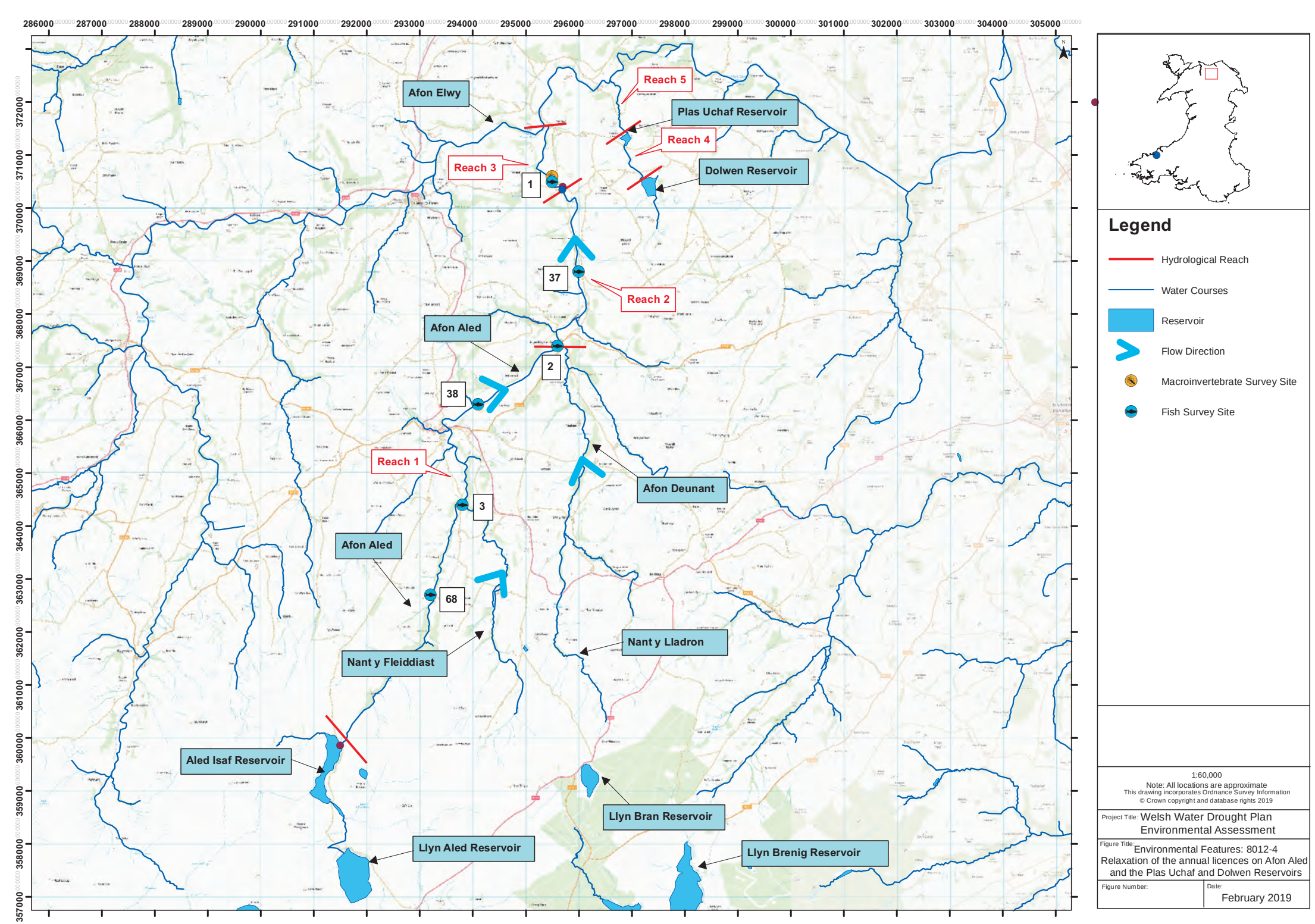
The ecological assessment has been undertaken recognising the IEMA[1][2] and the CIEEM study guidelines[3]. The assessment of impacts on other environmental receptors e.g. recreation and landscape has been carried out largely by qualitative expert judgement. Specific assessment methodologies for key environmental features are set out in **Appendix C**.

Desk-based assessments have been completed for each of the sensitive receptors, where applicable, in order to determine the magnitude of impact in the relevant lake and river reaches for the Aled Annual drought permit. Each feature assessment describes the analyses carried out and a statement of the assessed impact. All impacts are considered to be negative / adverse unless otherwise stated in the feature assessment.

This appendix is set out in the following sections:

Section D.2 WFD Status and Community Assessment / Notable Species
Section D.3 Landscape and Recreation

[1] IEMA (2004) Guidelines for Environmental Impact Assessment.
[2] IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK
[3] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.


Afon Elwy
Reach 5
Plas Uchaf Reservoir
Reach 4
Reach 3
1
Dolwen Reservoir
37
Reach 2
Afon Aled
2
38
Reach 1
3
Afon Deunant
Afon Aled
68
Nant y Lladron
Nant y Fleiddiast
Aled Isaf Reservoir
Llyn Bran Reservoir
Llyn Aled Reservoir
Llyn Brenig Reservoir
286000
287000
288000
289000
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292000
293000
294000
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N
Legend
Hydrological Reach
Water Courses
Reservoir
Flow Direction
Macroinvertebrate Survey Site
Fish Survey Site
1:60,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
© Crown copyright and database rights 2019
Project Title: Welsh Water Drought Plan Environmental Assessment
Figure Title: Environmental Features: 8012-4 Relaxation of the annual licences on Afon Aled and the Plas Uchaf and Dolwen Reservoirs
Figure Number:
Date: February 2019

D2 WFD STATUS AND COMMUNITY ASSESSMENT / NOTABLE SPECIES

D.2.1 Macrophytes

D.2.1.1 Baseline

The implementation of this drought permit will influence four reservoirs in the Afon Aled catchment and five river reaches which are located downstream of the reservoirs. Impacts to Llyn Aled and Aled Isaf are assessed as minor (as described in Appendix B), therefore no further assessment of these waterbodies has been carried out. Impacts for Plas Uchaf and Dolwen Reservoir are assessed as major, with assessment of the macrophyte communities undertaken below. Of the river reaches, impacts associated with drought permit as assessed as minor beneficial (Reach 1 & 2) to minor (Reach 3), with no impacts to Reaches 4 and 5. Therefore, no further assessment of these river reaches has been carried out.

No baseline macrophyte monitoring information was received from Natural Resources Wales (NRW) for the four potentially impacted reservoirs (Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf). Without data, the presence, extent and structure of macrophyte communities is not known and collection of baseline data on macrophyte communities of all four reservoirs is recommended to inform the assessment of impacts of the drought permit. In the absence of data, some general assumptions have been made in regard to the possible macrophyte communities present based on the location, size and normal operation of the waterbodies, in order to complete a preliminary assessment. However, due to the relative paucity of physical habitat, bathymetry and water chemistry data available for these reservoirs, teamed with the natural spatial variability of macrophyte communities, a low confidence in these predictive descriptions must be stressed.

Communities present are expected to reflect the heavily modified nature of the waterbodies and it is likely that the artificial drawdown regime of the reservoirs under normal operation will limit the diversity, extent, condition and ecological sensitivity of any such communities present. However, without macrophyte data, any firm assumptions regarding the presence, abundance and ecological importance of macrophyte communities of Llyn Aled and Aled Isaf reservoirs cannot be made.

Plas Uchaf and Dolwen Reservoirs

Plas Uchaf reservoir is a very small, low altitude, shallow, high alkalinity reservoir of 2 ha, with a 1 km perimeter and a mean depth of 6.3 m. The catchment is predominantly improved grassland with an additional mix of more natural grassland types and woodland also present. (CEH, 2016). Abstraction from the Plas Uchaf reservoir system occurs year round, but during the summer months Plas Uchaf acts as a balancing reservoir and receives water abstracted from the Afon Aled for storage until required for supply. Typically, therefore, water levels at Plas Uchaf do not vary much, ranging from around 14 m to 15 m above datum in most years, although levels did drop to about 12.5 m in September 2011 (see **Appendix B**).

Again, the location and catchment of Plas Uchaf reservoir suggest that it would support a macrophyte community typical of oligo-mesotrophic lakes as described above, however, given the very small size (2 ha) and mean depth of 6.3 m, the extent of shallow littoral areas is expected to be much more limited, which may in turn limit the diversity or extent of the macrophyte community. The high alkalinity and more intensive agricultural land use of the catchment (predominantly improved grassland) may result in a more productive system, potentially representing more mesotrophic conditions than the other three reservoirs.

Although the water levels in Plas Uchaf reservoir do not vary much (i.e. significant drawdown does not usually occur), the hydrological regime remains highly modified, with water levels artificially supported by waters abstracted from Aled Isaf. The macrophyte community is expected to reflect this, and would also be influenced by the water chemistry of the Aled Isaf water transferred during the summer months. Therefore, even if the macrophyte community is relatively diverse and extensive, it may not fully represent the community that would be expected in a more natural lake of this size, altitude and water chemistry. However, without macrophyte data, any firm assumptions regarding the presence, abundance and ecological importance of macrophyte communities of Plas Uchaf reservoir cannot be made.

Dolwen reservoir is a shallow, low alkalinity, low altitude reservoir of 7 ha, with a perimeter of 1 km and a mean depth of 2.8 m. It is fed by a 2.28 km^2 catchment of predominantly unimproved grassland (including neutral, acid and calcareous grassland) with some mixed woodland and a very small amount of arable land (1%) (CEH 2016). Under normal operating conditions water levels typically fluctuate by 4-5 m, ranging from 10.7 m to 15 m above datum. Reservoir level and storage data from 2000 to 2016 suggest that variability in reservoir levels are spread more evenly over the annual cycle than in Llyn Aled and Aled Isaf, but with the bulk of drawdown occurring between May and October and peak levels usually occurring in January-February. Any overflow from Dolwen Reservoir flows down a short stream which discharges into Plas Uchaf Reservoir (see **Appendix B**). Dolwen Reservoir can also be decanted into Plas Uchaf Reservoir.

The location, altitude and catchment of Dolwen reservoir suggest that it would support a macrophyte community typical of oligo-mesotrophic conditions, similar to that described for Llyn Aled and Aled Isaf above, but limited in development of hydroseres by the very shallow nature and small size of the water body. Extensive areas of littoral habitat would be expected given the mean depth (2.8 m) but the typical annual drawdown of 4-5 m suggests deeper areas are also present. Predominantly un-intensive land use in the catchment would suggest that oligotrophic conditions are likely which, teamed with low alkalinity, would limit productivity.

Macrophyte communities present are expected to reflect the highly modified nature of the waterbody and it is presumed that the majority of these littoral areas would typically be subject to exposure during drawdown over the summer months under normal operating conditions, limiting the potential for optimal habitat for many macrophyte species. However, without macrophyte data, any firm assumptions regarding the presence, abundance and ecological

importance of macrophyte communities of Dolwen reservoir cannot be made.

Notable species and habitats:

Where abundance of the characteristic plant species is high, the macrophyte community type described above is indicative of the EU Habitats Directive Annex I Habitat 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*. In addition to defining this habitat type, such communities can include notable plant species such as the EU Habitats Directive Annex II species floating water-plantain *Luronium natans*, Nationally Scarce UK BAP species pillwort *Pilularia globulifera*, or *Potamogeton*, charophyte, bryophyte or lichen species or assemblages of local, regional or national importance[4].

Where lake water has a high base content, usually associated with calcareous geology, the Annex 1 Habitat 3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. may be present, although this habitat type is less common in Wales than Habitat 3130. This habitat type is typified by abundant charophytes occurring in dense beds that cover a significant part of the lake bottom over muddy marl deposits. The presence of this habitat type is possible (although perhaps unlikely) in Plas Uchaf due to the high alkalinity of this reservoir.

Due to the artificial hydrological regimes, the Dolwen reservoir is considered unlikely to support a macrophyte community which fully represents either of these habitat types or the rarer species that are sometimes present in such waterbodies. The extent and diversity of associated macrophyte communities in Plas Uchaf may be limited by the small size and (potentially) depth profile of the reservoir, as well as the artificial hydrological regime. However, without data on the macrophyte communities of the reservoirs these habitat types and species of conservation importance cannot be presumed to be absent.

D.2.1.2 Assessment

Dolwen Reservoir

The hydrological impacts at Dolwen Reservoir are assessed as major between November and December. In the simulation of the baseline drought scenario, abstraction from the Dolwen reservoir would cease in early November. With the drought permit in place, the increased annual licence would allow additional water to be abstracted, leaving Dolwen Reservoir with 106Ml less water in storage by 31st December than in the baseline scenario. This is equivalent to a reduction in the water level of around 1.7m or 11% between November and December.

The continuation of abstraction for a further 53 days relative to the baseline scenario could potentially lead to an increase of up to 53 days in the time for which Dolwen Reservoir is drawn

[4]JNCC (2016) http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H3130

down below top water level, depending on the pattern of inflows from 1st January onwards.

This could affect the macrophyte community in a number of ways:

- Increased duration of desiccation of shallow water submerged and emergent macrophytes due to reduced water level;
- Increased temperatures and potentially nutrient concentration causing proliferation of phytoplankton or filamentous algae, resulting in shading of macrophyte stands and competition for dissolved gasses;
- Reduced habitat suitability for submerged macrophyte species which require deep water; and
- Encroachment of terrestrial or marginal vegetation into areas of shoreline exposed by reduced water levels.

The effects of the potential impacts outlined above would depend on the species present (i.e. are they tolerant to exposure/shading/changes in water quality), the rate of drawdown and the reservoir planform (i.e. where the normal hydrosere zones and maximum depth of colonisation occur in relation to the extent of the extended drawdown).

The timing and speed of the further drawdown under the drought permit would also influence the extent of the impact on the macrophyte community. The majority of the extended drawdown is expected to occur outside of the key period of macrophyte growth, limiting the potential impact of the drought permit on macrophyte communities (overall, but especially in relation to encroachment of terrestrial and marginal species and water quality impacts). It is possible that turions set during the late summer/early autumn and any "wintergreen" macrophyte species (such as charophytes) would be exposed during the autumn/winter drawdown, leading to increased desiccation and reduced or lost viability for regrowth the following year. Furthermore, the possible extension of delay in recharge to peak water levels into the spring months may affect the growth, development and distribution of the macrophyte community the following year.

The effect of the drought permit would depend on the species present, the rate of drawdown and the reservoir planform. Typically the reservoir levels range from about 10.7m to about 15m above datum, with the majority of drawdown occurring between May and October, encompassing the main macrophyte growing season. As such the macrophyte community present in the reservoir will likely be relatively tolerant to changes in water level and probably impoverished to some extent by this. Given the shallow nature of the waterbody, it is expected that much of the littoral areas will have already been exposed in the baseline drought scenario, but it is possible that a continuation of abstraction resulting in an increase of up to 53 days in the time for which the reservoir is drawn down below top water level may increase desiccation time. On return to the normal hydrological regime, communities would be expected to recover

from the seed bank or from populations surviving within the remaining wetted area and impacts are therefore likely to be short term and reversible, with recovery to baseline conditions within one to five years.

Given the uncertainty regarding the sensitivity of the macrophyte community the impacts have been classified as **moderate adverse**, short term and reversible**,** but with uncertainty due to lack of baseline data. This assessment could change either positively or negatively depending on the plant communities revealed by a baseline survey.

Plas Uchaf

The hydrological impacts at Plas Uchaf are assessed as major between November and December. Plas Uchaf is expected to generally be kept full, however, in severe drought conditions with high demands it is possible that some lowering of water levels may take place. Under the simulated normal drought scenario, abstraction from the Plas Uchaf would cease in early November; on implementation of the drought permit the increased annual licence would allow for further abstraction from this date until the end of the year. With the drought permit in place, abstraction from Plas Uchaf would continue for a further 53 days, potentially lowering water levels further or at least preventing them from recovering back to the normal level. With the drought permit in place and abstractions continuing to be required to meet high demand, there is an increased likelihood that water levels may remain below top water level rather than recover by the end of the year. The relative difference in water levels by 31st December could potentially be as great as 3.5m or 23%. The potential pathways that the drought permit may impact the macrophyte community are the same as those described for Dolwen Reservoir

The effect of the above would depend on the species present, the rate of drawdown and the reservoir planform. Water levels in Plas Uchaf are normally kept stable and typically range from about 14m to 15m above datum in most years (top water level being at 15m). As such the macrophyte community present is not expected to be tolerant to fluctuations in water level and therefore is likely to be reasonably sensitive to potential changes in water level brought about by implementation of the drought permit.

However, in the context of a drought scenario water levels are likely to drop to some extent before drought permit implementation and many of the macrophyte communities within the shallow margins may already been exposed, and any further drop would occur outside the main macrophyte growing season. However, species in deeper areas may be exposed by operation of the drought permit and the extended time at lower water levels may affect emergence of the macrophyte community in these areas the following year. Therefore, following a precautionary principal given the potential for sensitive communities and species to be present in Plas Uchaf, impacts on the macrophyte community have been assessed as **major adverse**, short-medium term and reversible, but with uncertainty due to a lack of baseline data. Given the timing of the operation of the drought permit (i.e. outside the macrophyte growing season), if baseline data reveals that the macrophyte communities of the reservoir are not ecologically sensitive and do not include rare or protected species, the

significance of impacts could reduce.

Summary

The potential impacts of the Aled Annual drought permit on the macrophyte community are summarised in **Table D2.2**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the macrophyte community. The impacts presented in **Table D2.2** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.2 Summary of Impacts on the Macrophyte Community

Feature	Impact	Significance of Impact
Dolwen Reservoir and Plas Uchaf		
Macrophytes	• Desiccation or reduced habitat suitability due to reduced water level, including exposure of wintergreen plants or vegetative dispersal mechanisms (turions) • Reduced habitat suitability for submerged macrophyte species which require deep water • Encroachment of terrestrial or marginal vegetation into areas of shoreline exposed by reduced water levels.	**Moderate**

There is a risk of short-term deterioration in status of the macrophyte component of the waterbody GB31033261 (Plas Uchaf and Dolwen Reservoirs) due to the drought permit. Impacts of drought permit implementation on the macrophyte communities of the impacted reservoirs have been summarised as moderate, short-term, temporary and reversible. Consequently, the macrophyte component of this waterbody is considered to be at and **minor** risk of short-term deterioration respectively.

D.2.2 Macroinvertebrates

D.2.2.1 Baseline

The implementation of this drought permit will influence four reservoirs in the Afon Aled catchment and five river reaches which are located downstream of the reservoirs. Impacts to Llyn Aled and Aled Isaf are assessed as minor (as described in Appendix B), therefore no further assessment of these waterbodies has been carried out. Impacts for Plas Uchaf and Dolwen Reservoir are assessed as major between November and December, with assessment of the macroinvertebrate communities undertaken below. Of the river reaches, impacts associated with drought permit as assessed as minor beneficial (Reach 1 & 2) to minor (Reach 3), with no impacts to Reaches 4 and 5. Therefore, no further assessment of these river reaches has been carried out.

No baseline macroinvertebrate monitoring information was received from NRW for the four potentially impacted reservoirs (Llyn Aled, Aled Isaf, Dolwen and Plas Uchaf). Survey of littoral macroinvertebrate communities is recommended to provide a baseline from which effects of the drought permit can be assessed. A short physical description of each of the reservoirs is provided in Section D2.1.1. Littoral macroinvertebrate communities present will depend upon the habitats afforded by the reservoir planforms, substrates, macrophyte communities and water chemistry but are likely to include representatives from groups including caddisflies, mayflies, dragon flies and damsel flies, beetles, flatworms and leaches, bugs and true flies. Molluscs such as snails and mussels would also be expected unless conditions are too acidic (a possibility for Dolwen Reservoir).

Overall, littoral macroinvertebrate communities are expected to reflect and be adapted to the normal drawdown regime of the reservoirs, which is expected to limit the diversity and sensitivity of the communities present. However, although less likely than in unmodified waterbodies, the presence of locally or nationally scarce or rare species cannot be ruled out and, without baseline data, firm assumptions regarding the ecological sensitivity of the macroinvertebrate communities of these reservoirs cannot be made.

Notable species

No records of white-clawed crayfish *Austropotamobius pallipes* were present in the data returned for any of the waterbodies potentially affected by the drought permit. Consequently, white-clawed crayfish are assumed to be absent from the impacted reaches of the drought permit and are not considered further as part of this assessment.

The absence of freshwater pearl mussel has previously been confirmed (Adrian Fowles, CCW, pers. comm.)[5] and it is not considered further in this assessment.

D.2.2.2 Assessment

Without baseline data, the sensitivity and conservation importance of the macroinvertebrate communities of the Dolwen and Plas Uchaf reservoirs is not known and this assessment should therefore be considered indicative only.

Dolwen Reservoir

The hydrological impacts at Dolwen Reservoir are assessed as major between November and December, coinciding with a decrease in water levels by around 11% by the end of the year.

An increase in the delay to top water level recovery of 53 days would potentially increase the exposure duration for any communities in the margins and macrophyte habitats already exposed under drought conditions. This effect may continue into the spring and summer season, depending on rainfall patterns, due to the delay in refill caused by abstraction in the

[5] Cascade Consulting (2007). Environmental Monitoring Plan for Aled Isaf Reservoir (N7). Technical report to Dwr Cymru Welsh Water

autumn/winter months. The possible effects of these changes on macroinvertebrate communities could include a loss of habitat, increased competition (for resources) and predation, stranding and moderate risk of dissolved oxygen deterioration, all potentially impacting macroinvertebrate community composition and abundance.

However, due to the limited duration of the drought permit operation, following refill on return to the normal hydrological regime, littoral macroinvertebrates communities are expected to recolonise either from the remaining habitats within the reservoir or from other local sites.

Typically reservoir levels range from about 10.7 to about 15m above datum. As such the macroinvertebrate community present will likely be tolerant to significant changes in water level. As much of this drawdown will occur in the baseline of a natural drought scenario the impact on the macroinvertebrates is likely to be short-term, temporary, and reversible and therefore the hydrological impacts of the drought permit on the macroinvertebrate community are assessed as **moderate adverse** (uncertain due to lack of data).

Plas Uchaf

The hydrological impacts at Plas Uchaf are assessed as major between November and December, coinciding with a decrease in water levels by around 23% by the end of the year.

The possible effects of these changes on macroinvertebrate communities is the same as those described for the Dolwen Reservoir. However, due to the limited duration of the drought permit operation, following refill on return to the normal hydrological regime, littoral macroinvertebrates communities are expected to recolonise either from the remaining habitats within the reservoir and the waterbody upstream.

Water levels in Plas Uchaf are normally kept stable and typically range from about 14m to 15m above datum in most years (top water level being at 15m). As such the macroinvertebrate community present is not expected to be tolerant to fluctuations in water level and therefore is likely more sensitive to potential changes in water level brought about by implementation of the drought permit. However, in the context of a drought scenario, water levels are likely to drop before drought permit implementation and many of the macroinvertebrates within the shallow margins would have already been exposed. Therefore, impacts on the macroinvertebrate community are likely to be short-term, temporary, and reversible and therefore the hydrological impacts of the drought permit on the macroinvertebrate community are assessed have been assessed as **moderate adverse**, (uncertain due to lack of data).

Table D2.4 Summary of Impacts on Macroinvertebrate Community

Feature	Impact	Significance of Impact
Dolwen and Plas Uchaf Reservoirs		
Macroinvertebrates	• Loss of the littoral zone resulting in potential desiccation and loss of habitat (reduction in abundance). • Increased competition and predation rates. • Reduction in species diversity.	**Moderate**

There is a risk of short-term deterioration in status of the macroinvertebrate component of the waterbody GB31033261 (Plas Uchaf and Dolwen Reservoirs) due to the drought permit. Impacts of drought permit implementation on the macroinvertebrate communities of the impacted waterbodies have been summarised as moderate, adverse, short-term, temporary and reversible. Consequently, the macroinvertebrate component of this waterbody is considered to be at **moderate** risk of short-term deterioration.

D.2.3 Fish

D.2.3.1 Baseline

Existing data –Plas Uchaf and Dolwen Reservoir

No NRW fish survey data were made available for the Aled, Dolwen and Plas Uchaf Reservoirs. The only information available is anecdotal evidence from angling-related media.

Species composition

There are no fish survey data for either of the reservoirs. The only information available is anecdotal evidence from angling-related media which suggests that Dolwen and Plas Uchaf reservoirs are managed as stocked rainbow trout *Oncorhynchus mykiss* and brown trout fisheries.

Brown trout

Anecdotal angling media suggest that brown trout are present in both reservoirs. The stocking of brown trout for angling purposes may influence population dynamics, potentially reducing any impacts associated with the implementation of a drought permit. Spawning of any wild fish that are present in either reservoir may occur within the lakes themselves or the feeder streams.

Other species

Rainbow trout are believed to be stocked into the reservoirs. As rainbow trout are of recreational importance only, and are assessed as having no conservation value, they are not assessed further in Section D2.

Data limitations

In order to obtain a suitable baseline for the two reservoirs fish population surveys in one year would be required and details on stocking practices.

Ecological value of fisheries receptors

Brown trout (Environment (Wales) Act) are considered to be of National importance, however, artificial stocking of the species is likely to have impacted upon the dynamics of any natural/wild population.

D.2.3.2 Assessment

The hydrological impacts at Dolwen and Plas Uchaf Reservoirs are assessed as major between November and December, coinciding with a decrease in water levels by around 11% and 23% respectively by the end of the year.

An increase in the magnitude and/or frequency of water level fluctuations (whether natural or artificial) in standing waters can have direct and indirect impacts on fish communities, particularly associated with habitat loss or degradation in the littoral zone. The fish populations in the Aled reservoirs may be particularly sensitive to increased littoral exposure at particular times of year due to a potential loss of spawning or foraging habitat. In addition, resident brown trout are likely to migrate to spawning grounds in upstream tributaries and any loss of connectivity with these tributaries during migratory windows may impact recruitment. In addition, intra- and inter-specific interactions (e.g. increased competition for optimal habitat and food)[6,7], reduced water quality and reduced reproductive success, growth and condition[8] may result from the implementation of a drought permit.

Potential impacts relating to habitat loss and water quality are of relevance. These are discussed for key fish species in the sections which follow with particular focus on those aspects of fish ecology (e.g. spawning and juvenile life stages) most susceptible during the period November to December (inclusive) drought permit implementation period.

Brown trout

Habitat connectivity

It is likely that native (wild) brown trout in both reservoirs migrate to spawning grounds in upstream tributaries and this is likely to occur between October and December, coinciding with the drought permit implementation period. Whilst connectivity with upstream tributaries may be compromised prior to a drought permit, the increased duration of reduced connectivity

[6] Magoulick, D.D. (2000). Spatial and temporal variation in fish assemblages of drying stream pools: the role of abiotic and biotic factors. Aquatic Ecology 34, 29-41
[7] Davey A.J.H. & Kelly D.J. (2007). Fish community responses to drying disturbances in an intermittent stream: a landscape perspective. Freshwater Biology 52, 1719–1733.
[8] Magoulick, D.D. and Kobza, R.M. (2003). The role of refugia for fishes during drought: a review and synthesis. Freshwater Biology 48, 1186-1198.

is likely to pose a higher risk to recruitment. The impact of reduced spawning habitat connectivity on wild brown trout in both reservoirs is considered medium, short term, temporary and reversible. Fish population surveys would be required in order to understand the dynamics and habits of any native brown trout population in each reservoir. The impact is therefore considered **minor adverse**.

Brown trout habitat loss

The littoral zone is likely to provide important foraging habitat for brown trout and a significant reduction in this habitat could potentially result in increased competition, stress and mortality, particularly in the more sensitive juvenile year classes. It is likely that a reduction in littoral habitat would have a direct impact on foraging as well as a longer-lasting impact on prey availability. The hydrological impact on both reservoirs has been assessed as being major adverse and the impact on brown trout is considered to be of moderate magnitude, short-term, temporary and reversible. The impact of a loss of foraging habitat is therefore considered to be **moderate adverse**.

Water Quality

Brown/sea trout are susceptible to poor water quality and particularly dissolved oxygen and water temperature. There is a medium risk of dissolved oxygen deterioration in both reservoirs. The impact is therefore considered to be medium, short-term, temporary and reversible. The impact on brown trout is therefore considered to be **moderate adverse**.

Summary

The potential impacts of the drought permits of both reservoirs on the fish community are summarised in **Table D2.8**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the fish community. The impacts presented in **Table D2.8** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.8 Summary of Impacts on Fish Community

Feature	Impact	Significance of Impact
Dolwen and Plas Uchaf Reservoirs		
Brown trout	• Reduced connectivity between reservoir and spawning tributaries for wild brown trout	**Minor**
	• Reduced water quality	**Moderate**
	• Reduction in juvenile survival due to habitat loss and a reduction in adult abundance	**Moderate**

There is a risk of short-term deterioration in status of the macroinvertebrate component of the waterbody GB31033261 (Plas Uchaf and Dolwen Reservoirs) due to the drought permit. Impacts of drought permit implementation on the macroinvertebrate communities of the impacted waterbodies have been summarised as moderate, adverse, short-term, temporary and reversible. Consequently, the fish component of this waterbody is considered to be at **moderate** risk of short-term deterioration.

D.2.4 Phytoplankton

D.2.4.1 Baseline

No baseline phytoplankton monitoring information was received from Natural Resources Wales (NRW) for any of the four reservoirs affected by the scheme (Llyn Aled, Aled Isaf, Dolwen Reservoir and Plas Uchaf). Considering the absence of baseline information care must be taken in interpretation of the assessment and it should be seen as indicative only. The 2018 interim cycle 2 classification of the GB31033261 (Plas Uchaf and Dolwen Reservoirs) assessed the phytoplankton element as moderate status, with phytoplankton blooms and total phosphorous noted as the driving factor behind the overall moderate waterbody status.

D.2.4.2 Assessment

Phytoplankton levels and community composition within Dolwen and Plas Uchaf Reservoirs may be affected by the drought permit due to changes in temperature and potentially nutrients released from sediment as the water volume decreases beyond what would be experienced under the normal abstraction scenario. This could potentially include an increase in phytoplankton density and potentially the triggering of blue-green algal blooms.

However, due to the timing of the drought permit (i.e. taking effect between November and December (inclusive)) this would be unlikely unless the weather experienced during these typically cooler months was unseasonably warm. Delay in refill the following year could potentially affect phytoplankton communities in spring, depending on the rate of refill following a return to the normal abstraction regime. Effects on phytoplankton over winter would be expected to be limited. The magnitude of impact on phytoplankton populations on

both reservoirs will be determined largely by their existing water quality status and also the refill rate following cessation of the drought permit, but are expected to be **negligible** for both reservoirs.

Summary

The potential impacts of the Aled reservoirs drought permit on the diatom community are summarised in **Table D2.11**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the diatom community. The impacts presented in **Table D2.11** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.11 Summary of Impacts on Diatom Community

Feature	Impact	Significance of Impact
Dolwen and Plas Uchaf Reservoirs		
Phytoplankton	• Increases in temperature and nutrients released from sediment as the water volume decreases • Increase in phytoplankton density and potentially the triggering of blue-green algal blooms	**Negligible**

As the significance of impact to the phytoplankton community in both reservoirs is assessed as negligible, there is no risk of a short-term deterioration in status of the phytoplankton component of the waterbody GB31033261 (Plas Uchaf and Dolwen Reservoirs) due to the drought permit.

D3 LANDSCAPE AND RECREATION

D.3.1 Landscape and Recreation

D.3.1.1 Baseline

The upper catchment lies within the Mynydd Hiraethog area and its upland moorland with steep valleys. The open moorlands and lakes are attractive to walking enthusiasts. Land use within the less fertile upper reaches of the study area is predominantly mixed livestock with dairy farming in the lower reaches. Moderate access is provided by footpath and road to the reservoir. Plas Uchaf and Dolwen reservoirs are popular locations for recreational fishing.

D.3.1.2 Assessment

Water levels in both reservoirs would be reduced below their lowest typical operating level due to drought and the drought permit. Changes to water levels and wetted width directly affect the landscape, fishing and visual amenity value, although this will only be temporary and will

be ameliorated once the drought has passed. Therefore, the landscape and recreational impacts are assessed with limited data as having a **negligible** risk.

Summary

The potential impacts of the Aled reservoirs drought permit on landscape and recreation are summarised in **Table D4.1**. The impacts presented in **Table D4.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D4.1 Summary of Impacts on Landscape and Recreation

Feature	Impact	Significance of Impact
Plas Uchaf and Dolwen Reservoirs		
Landscape	• Reduction in the water levels would affect the visual amenity of the landscape, however water levels would also be reduced	**Negligible**
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**