Dŵr Cymru Welsh Water

Environmental Assessment of Aled Isaf Drought Permit (8012-2)

Final

March 2019

Client:	**Dŵr Cymru Welsh Water**
Title:	**Environmental Assessment of Aled Isaf Drought Permit (8012-2)**
Project No:	**ED10929**
Date of Issue:	**March 2019**
Status:	**Final**
Version No:	**1.5**

Produced By

Dr Anne Fairhead
Principal Environmental Scientist

Authorised for Release By

John Sanders
Technical Director

*As part of a share purchase agreement in August 2015, Cascade Consulting (Environment & Planning) Ltd transferred its business to Ricardo plc. All employees transferred to Ricardo Energy & Environment, a trading name of Ricardo-AEA Ltd which is a wholly owned subsidiary of Ricardo plc. The work described in this report spanned the pre-acquisition and post-acquisition period and throughout this time the consultants involved maintained a continuity of service both as employees of Cascade Consulting and then subsequently as employees of Ricardo Energy & Environment.

CONTACT DETAILS:

Ricardo Energy & Environment Bright Building, First Floor
Manchester Science Park
Pencroft Way
Manchester
M15 6SZ

Tel: +44 (0)1235 753000

ISO 9001 REGISTERED FIRM

ISO 14001 REGISTERED FIRM

iema EIA

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 drought management measure 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 Aled Isaf, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Aled Isaf is located in Welsh Water's Clwyd Coastal Water Resource Zone (WRZ). The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

The Coed Nant-y-Merddyn-Uchaf Site of Special Scientific Interest (SSSI), Coed Llys-Aled SSSI and Mnydd Hiraethog SSSI are located within the study area. Consideration has, therefore, been given to the potential impacts of drought permit implementation on these statutory designated sites.

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 with the latest information to support any future required application by Welsh Water to Natural Resources Wales for a drought permit at Aled Isaf.

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 Natural Resources Wales for a drought permit to vary the conditions of its Afon Aled at Bryn Aled abstraction licence.

If granted, the drought permit would allow a reduction of 1Ml/d in the required

regulation release rate from Aled Isaf Reservoir to the Afon Aled whenever abstraction is required during the residual flow period of 1 February to 31 May, together with a reduction of 1M/d in the residual flow condition at Bryn Aled intake. During the period of 1 June to 31 January, the drought permit involves a proposed reduction of 2Ml/d in the regulation release rate from Aled Isaf Reservoir whenever abstraction is taking place and residual flow at Bryn Aled is below 29.5Ml/d. This would conserve the longevity of total reservoir storage for regulation releases to the Afon Aled for abstraction at the Bryn Aled intake.

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

The revised abstraction arrangements under the drought permit would be authorised for a maximum of five months (September-January), but would be removed sooner if the water resources situation within the Clwyd Coastal WRZ returns to adequate levels to safeguard essential water supplies, as agreed with 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 options considered by Welsh Water to maintain essential water supplies to its customers will be completed at the time of application for the drought permit. This will provide further justification for the need for the drought permit.

POTENTIAL IMPACTS OF DROUGHT PERMIT IMPLEMENTATION

The scope of this drought permit environmental assessment has been defined by a screening and scoping exercise in accordance with national drought planning guidance.

Summary of the Hydrological Assessment for the Afon Aled

The assessment has concluded that there is a **moderate** impact on river flows as a result of implementing the drought permit. There are also medium risks to the physical environment of the river, including water quality.

Summary of the Environmental Features Screening for the Afon Aled

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified Coed Llys-Aled SSSI, Coed Nant-y-Merddyn-Uchaf SSSI, Mnydd Hiraethog SSSI, WFD Status and Community Assessment / Environment (Wales) Act Section 7 Species, and landscape and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that there are **moderate** impacts on aquatic ecology, specifically: moderate impacts on fish, and minor impacts on macroinvertebrates, macrophytes and phytobenthos. Impacts on designated sites were assessed as negligible.

Cumulative Impacts

No cumulative effects of implementing the drought permit with other 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 Aled Isaf.

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought permit at Aled Isaf. Consequently, in line with the DPG, an Environmental Monitoring Plan has been proposed. Further discussion with NRW is required in order to develop suitable mitigation measures.

CONCLUSIONS

It has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at Aled Isaf would be **moderate.** This includes consideration of the effects on Sites of Special Scientific Interest in accordance with the requirements of the Crow Act.

Contents

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 temporarily modify the abstraction licence conditions to allow a reduction in the statutory compensation release from Aled Isaf Reservoir to the Afon Aled Reservoir in the Clwyd Coastal Water Resource Zone (WRZ)[1] (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 Aled Isaf. 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 September to January. 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 Aled Isaf drought permit covers the following waterbodies:

- Aled Isaf (GB110066054930) upstream of confluence with Afon Deunant
- Aled Isaf (GB110066059770) from Afon Elwy confluence to Afon Deunant confluence

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**)

[1] UKWIR/Environment Agency define a WRZ as: 'The largest possible zone in which all resources, including external transfers, can be shared, and hence, the zone in which all customers will experience the same risk of supply failure from a resource shortfall.'

- 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 / Natural Resource Wales Drought Plan Guideline[2] (DPG); specifically Section 5 and Appendix I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders[3].

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 assessments 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

[2] 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.

[3] Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, https://www.gov.uk/guidance/apply-for-a-drought-order-or-emergency-drought-order#after-youve-received-your-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 Aled Isaf, 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

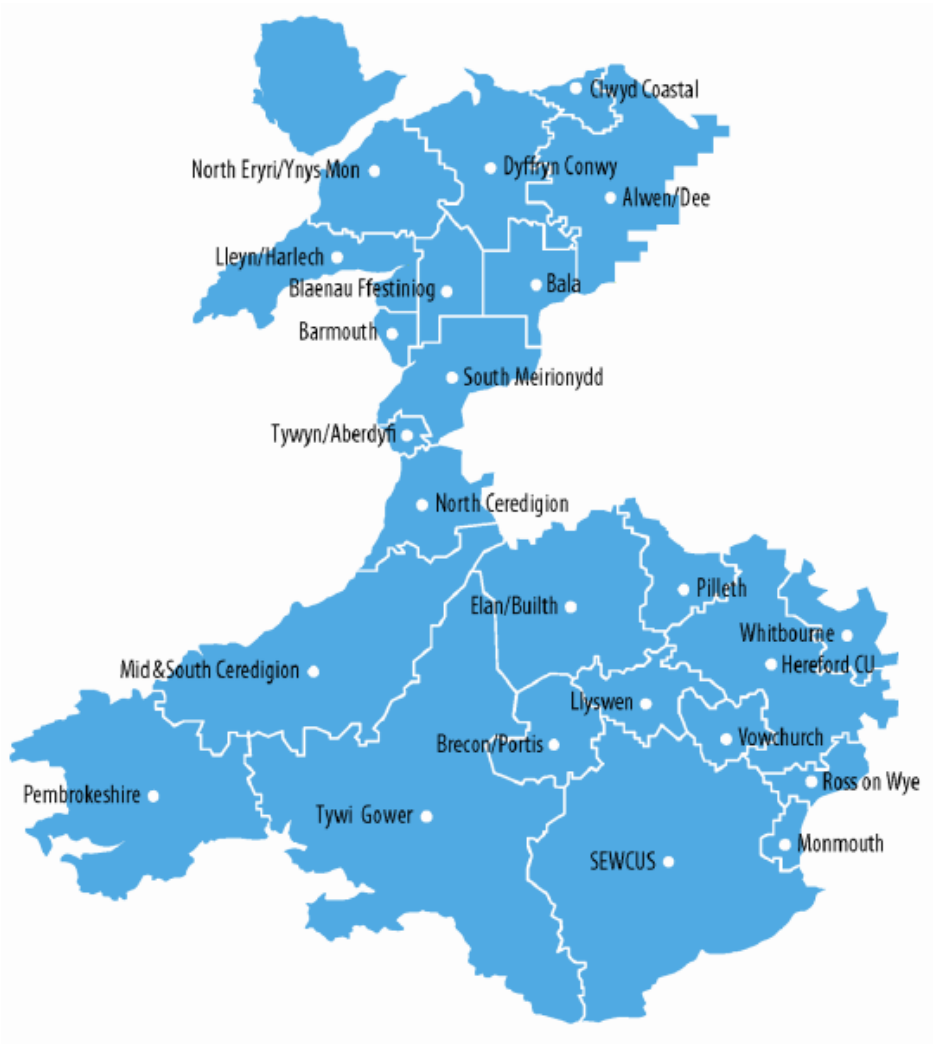
2 BACKGROUND TO THE DROUGHT PERMIT

2.1 WELSH WATER'S SUPPLY SYSTEM

Welsh Water supply 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)**.

The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

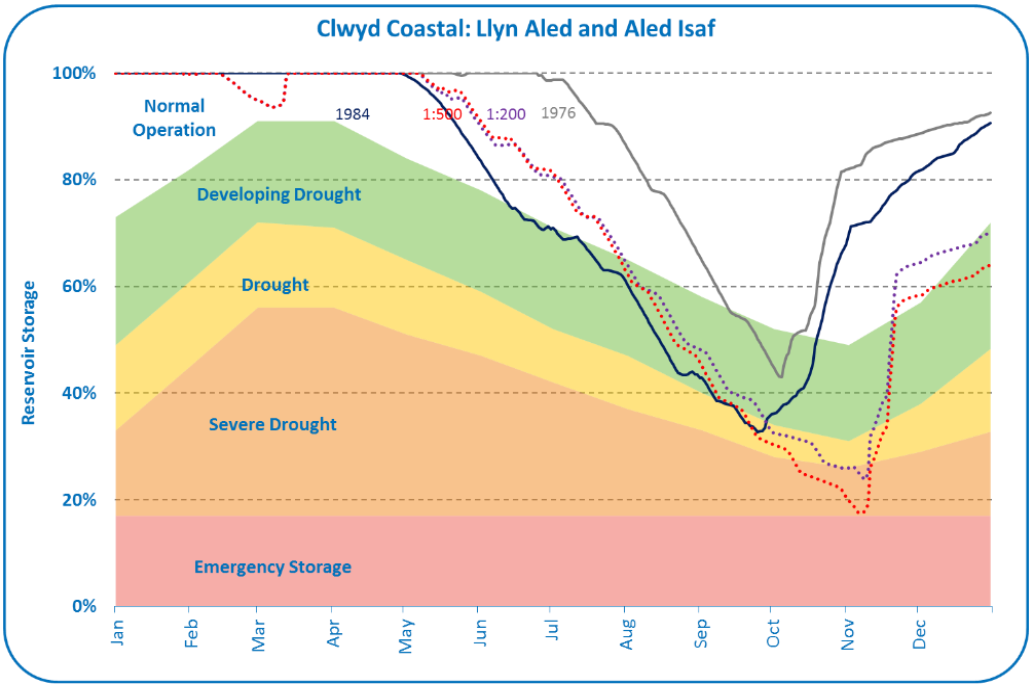
Figure 2.1 Welsh Water Water Resource Zones



Aled Isaf Reservoir is located on the mainland, in the Clwyd Coastal region. The trigger levels for applying for a drought permit at Aled Isaf are based on combined reservoir storage in Aled Isaf and Llyn Aled, falling below a defined level; this is shown in **Figure 2.2** (dark 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 Aled Isaf Drought Action Zones and Historic Droughts



2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT ALED ISAF

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 WRZ. The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions:

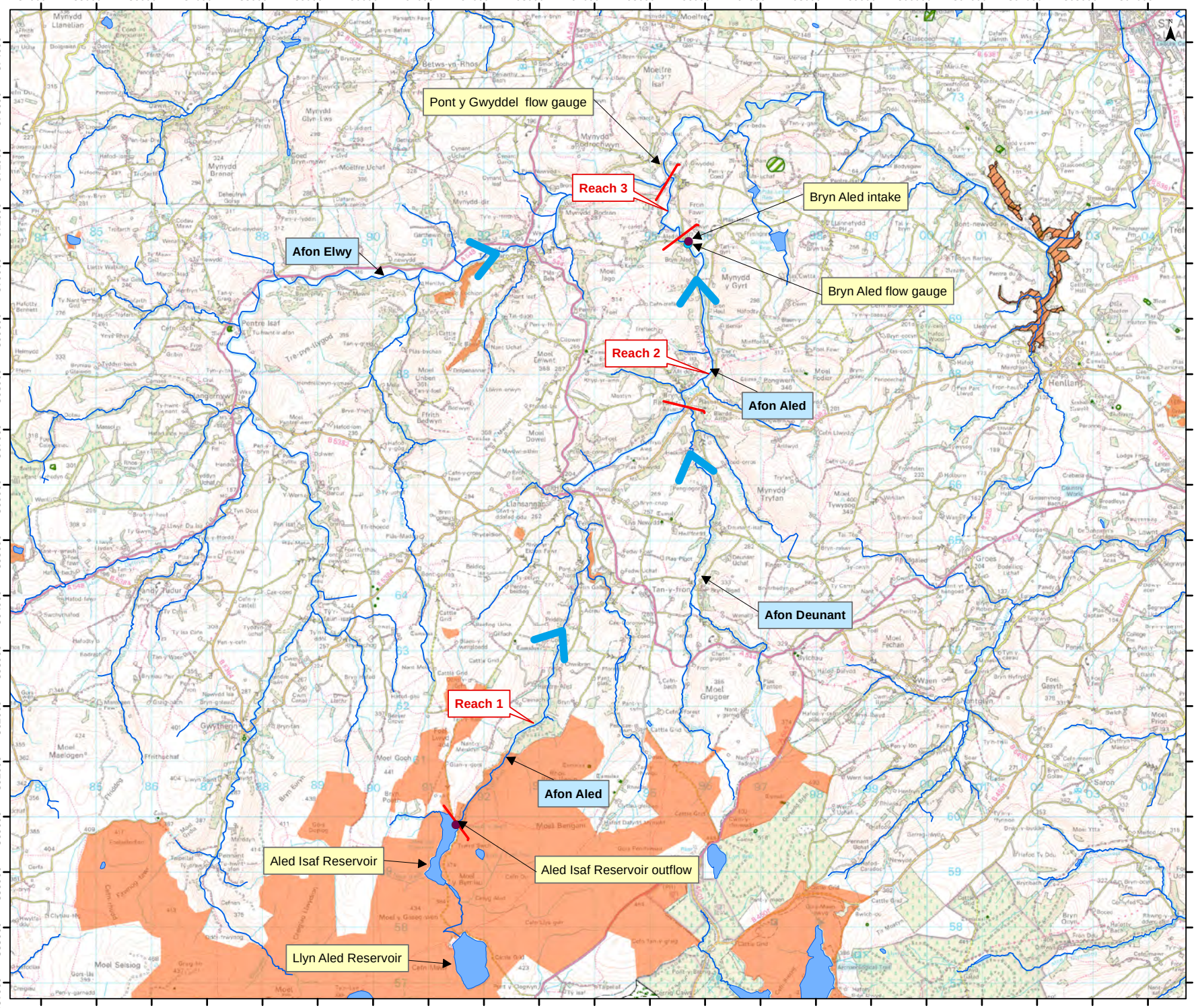
- 4,318 million litres (Ml) authorised to be abstracted per annum
- Abstraction rate of 27.3Ml/d
- The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases 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 intake:
        - From 1 February to 31 May inclusive, and when the Bryn Aled intake is in operation: controlled releases from Aled Isaf

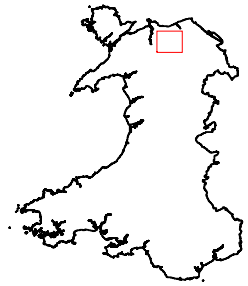
Reservoir maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake

- From 1 June to 31 January inclusive: 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 releases (made from a bank of water reserved in the licence under the terms of the Section 20 Operating Agreement with NRW).

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





Legend

- Hydrological Reach
- Reservoir
- Water Courses
- Abstractions
- Flow Gauge
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments
- Direction of Flow

RICARDO

Dŵr Cymru Welsh Water

1:65,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Study Area: 8012-2 Reduction in regulation release from Aled Isaf

Figure Number: Figure 2.3

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 Afon Aled at Bryn Aled abstraction licence.

The drought permit involves a proposed reduction of 2Ml/d in the required regulation release rate from Aled Isaf Reservoir to the Afon Aled whenever abstraction is required during the residual flow period of 1 June to 31 January, together with a reduction of 2M/d in the residual flow condition at Bryn Aled intake. This would conserve the longevity of total reservoir storage for regulation releases to the Afon Aled for abstraction at the Bryn Aled intake. The drought permit scheme will potentially influence the downstream Afon Aled.

Details of the existing and proposed drought permit abstraction at Aled Isaf are presented in **Table 2.1**.

The timing of the reduction in the regulation release is most likely to occur during the late summer to early winter period (within the period 1 September to 31 January). This is based on modelling of the two Aled reservoirs' performance under normal operating conditions, together with Welsh Water's experience of operating the source.

Table 2.1 Aled Isaf Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit Ml/d
Afon Aled	SH 91700 59900	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 • Abstraction rate of 27.3 Ml/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.	The drought permit involves a proposed reduction of 1Ml/d in the required regulation release rate from Aled Isaf Reservoir to the Afon Aled whenever abstraction is required during the residual flow period of 1 February to 31 May, together with a reduction of 1M/d in the residual flow condition at Bryn Aled intake. During the period of 1 June to 31 January, the drought permit involves a proposed reduction of 2 Ml/d in the regulation release rate from Aled Isaf Reservoir whenever abstraction is taking place and residual flow at Bryn Aled is below 29.5Ml/d. This would conserve the longevity of total reservoir storage for regulation releases to the Afon Aled for abstraction at the Bryn Aled intake.	1.0

[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 September to January, 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 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 a the continuation of a compensation release from Aled Isaf of 2.27Ml/d (daily average) and seasonal (July to October) fisheries releases of between

2.0 to 3.8Ml/d, as per existing arrangements. The baseline also includes the continuation of daily abstraction at Bryn Aled intake on Afon Aled for potable supply. This represents normal operating arrangements during a typical summer / autumn period.

3 APPROACH

3.1 INTRODUCTION

The DPG states that the environmental report must include information on:

i. 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 screening approach taken. This has provided the relevant study area for the drought permit assessment 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.

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, Natural Resource Wales Drought Plans
- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

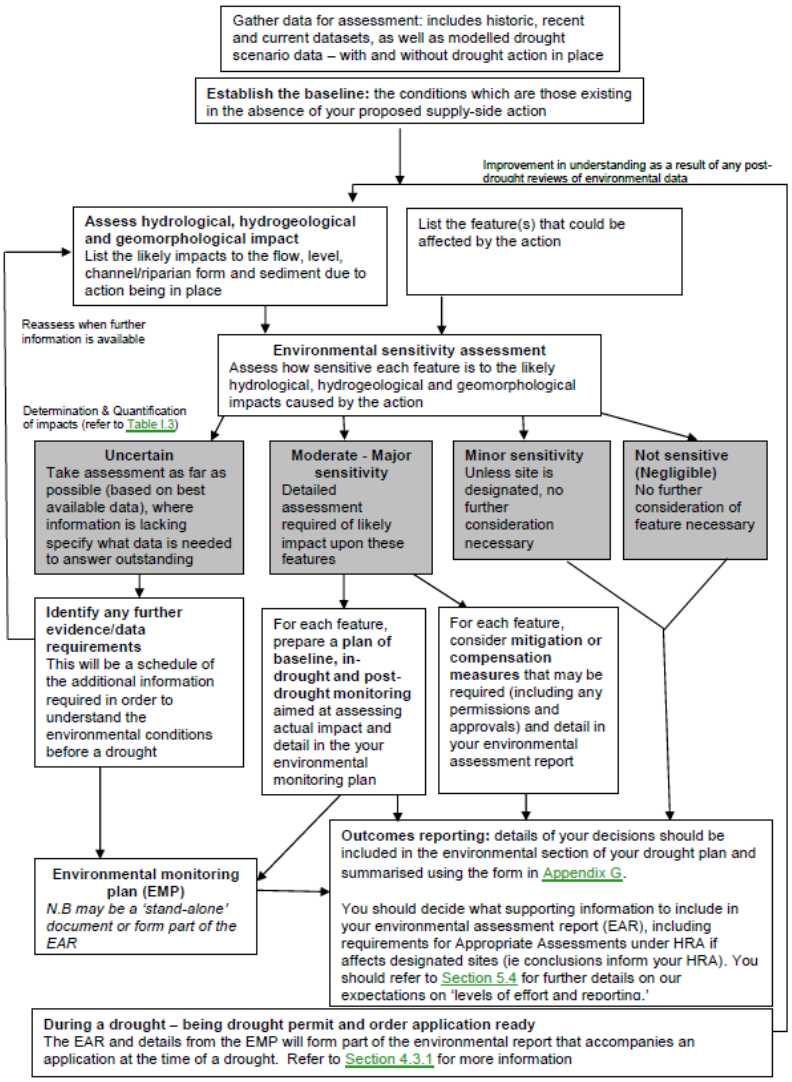
This is discussed further in Section 7.

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 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.
- identify the drought conditions which trigger the proposed action;
    - identify the drought conditions which trigger the proposed action;

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** – this is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified as**:**
    - *Major (High)*: There is a long-term large-scale (i.e. catchment) change in the physical environment.
    - *Moderate (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.
    - *Minor (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 outcome 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 Aled Isaf.

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 & archaeology 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 outcomes 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 Aled Isaf 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. DPG Figure 5 categorises four outcomes 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.

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 Water Company Drought Plan Technical Guideline (DPG)
- 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[4]
- 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)

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

- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
- 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 the Secretary of State 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.

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 DPG states that mitigation and / or monitoring is not required for features where minor (unless a site is designated) or negligible impacts are identified.

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. 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 and 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 ALED ISAF 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 Aled Isaf 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 the 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:

The study area (see **Figure 2.3**) is identified as Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy.

2) 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
- Change in levels in Llyn Aled Reservoir and Aled Isaf Reservoir

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 September to January.

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

Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir	
River Flows in the Afon Aled *Minor impacts during the period September-January*	• Reduction in regulation releases could result in a flow reduction of up to 15% (September) or 17% (October-January)
Water quality in the Afon Aled *Low risk during the period September-January*	• Low risk of deterioration linked to all determinands
Afon Aled (Reach 2) – downstream of Afon Deunant	
River Flows in the Afon Aled *Minor impacts during the September; negligible impacts during the period October-January*	• Reduction in regulation releases could result in a flow reduction of up to 11% (September) or 9% (October-January)
Water quality in the Afon Aled *Low-medium risk during the period September-January*	• Low risk of deterioration linked to total ammonia, dissolved oxygen, assumed medium risk for soluble reactive phosphorous)
Afon Aled (Reach 3) – downstream of Bryn Aled	
Flows in the Afon Aled *Moderate impacts during September; minor impacts during the period October-January*	• Reduction in regulation releases could result in a flow reduction of up to 19% (September) or 14% (October-January)
Water quality in the Afon Aled *Low-medium risk during the period September-January*	• Low risk of deterioration linked to total ammonia and dissolved oxygen; medium risk for SRP due to some recent standard failures

5 ALED ISAF 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 9 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 Aled Isaf 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)**
Coed Llys-Aled SSSI	Minor	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. Upland oak woodland considered to be highly water dependent.	Minor	Yes
Coed Nant-y-Merddyn-Uchaf SSSI	Minor	A mixed deciduous woodland, also representing one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions. Upland oak woodland considered to be highly water dependent.	Minor	Yes
Mynydd Hiraethog SSSI	Minor	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 sand piper. 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.	Minor	Yes
Macrophyte communities	Minor / Moderate	Reduction in flow and levels as a result of the drought permit could temporarily reduce the overall extent and / or quality of habitat availability for freshwater macrophytes in the study area.	Moderate	Yes
Benthic macroinverebrate communities	Minor / Moderate	The hydrological impacts are anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats and reduce habitat suitability by altering habitat suitability for flow sensitive species.	Moderate	Yes
Notable Species – Fish Brook lamprey *Lampetra planeri* Atlantic salmon *Salmo salar* Bullhead *Cottus gobio* Brown and sea trout *Salmo trutta*	Minor / Moderate	Reduction in level and flow is anticipated to reduce the availability of habitat for fish, increase the risk of predation and impact on fish movement in the river.	Moderate	Yes
Notable Species – Mammals Otter *Lutra lutra*	Minor / Moderate	Otter are known to be present in the catchment, however these species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be altered.	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)
Invasive flora and fauna – New Zealand pigmyweed *Crassula helmsii*	Minor / Moderate	New Zealand pigmyweed *Crassula helmsii* may be present in the catchment . There is uncertainty surrounding the likely effect of flow velocity and level impacts on the invasive species ability to distribute further within the watercourse	Uncertain	No
Landscape and visual amenity	Minor / Moderate	The study area is located in the Conwy Uplands Cultural landscape area and the Mynydd Hiraethog Cultural landscape area.	Uncertain	Yes
Recreation	Minor / Moderate	The area is used for a range of recreational activities including salmon and coarse fishing walking, canoeing, sailing and windsurfing. Any reduction in compensation releases may influence the water-dependant activities for a short period of time.	Uncertain	Yes

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 ecological status or potential and/or high / good 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	Aled - above Deunant (GB110066054930)		Aled - Elwy to Deunant (GB110066059770)	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Minor		Minor / Moderate	
Heavily Modified Waterbody (Y/N)	Yes		Yes	
RBMP Cycle	RBMP2 (2015)[5]	2018 Cycle 2 Interim Classification	RBMP2 (2015)[6]	2018 Cycle 2 Interim Classification
Overall Biological	Good	Good	Good	Good
Fish	High	High	High	High
Macrophytes	Not assessed	Not assessed	Not assessed	Not assessed
Phytobenthos	Not assessed	Not assessed	Not assessed	Not assessed
Macro-invertebrates	High	High	High	High
Total P/ Phosphate	Good	High	High	High
Ammonia	High	High	High	High
Dissolved Oxygen	High	High	High	High
pH	High	High	High	High
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Minor		Moderate	
Further Consideration Required (Y/N)	Yes		Yes	

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 5.2.1, 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 relevant river reaches for the Aled Isaf Reservoir

[5] NRW (2017) https://drive.google.com/file/d/0B2hsDbbdxz1tZHItRU9lNkg1YWs/view.
[6] NRW (2017) https://drive.google.com/file/d/0B2hsDbbdxz1tZHItRU9lNkg1YWs/view.

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. The approach is described in Section 3.3.

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 – 5.3.6.

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
Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)													
Coed Llys-Aled SSSI		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Coed Nant-y-Merddyn-Uchaf SSSI		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Mynydd Hiraethog SSSI		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Macrophytes		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Phytobenthos		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Risk to WFD waterbody macrophyte/phytobenthos status			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				
Risk to WFD waterbody macroinvertebrate status			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Atlantic Salmon, Brown / Sea trout	Adult upstream migration	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N			
	Water quality		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Spawning and juveniles (loss of habitat)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Bullhead			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
European eel (silver eel migration)			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Lamprey	Upstream migration (river lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Downstream migration (sea lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Juvenile (ammocoete and transformer) brook and river lamprey habitat	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
	Water quality	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Other fish species- Minnow, Stone loach and Three-spined stickleback			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Landscape and Visual Amenity		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Recreation		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Reach 2 – Afon Aled (Afon Deunant confluence to Bryn Aled intake)													
Macrophytes		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Phytobenthos		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Macroinvertebrates			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Atlantic Salmon, Brown / Sea trout	Adult upstream migration	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N			
	Water quality		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Spawning and juveniles (loss of habitat)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Bullhead			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
European eel (silver eel migration)			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Lamprey	Upstream migration (river lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				

Month		J	F	M	A	M	J	J	A	S	O	N	D
	Downstream migration (sea lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Juvenile (ammocoete and transformer) brook and river lamprey habitat	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
	Water quality	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Other fish species- Minnow, Stone loach and Three-spined stickleback			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			
Landscape and Visual Amenity		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N
Recreation		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N
		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence													
Macrophytes		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N
Phytobenthos		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N
Macroinvertebrates		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N
Atlantic Salmon, Brown / Sea trout	Adult upstream migration	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N			
	Water quality		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Spawning and juveniles (loss of habitat)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Bullhead			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
European eel (silver eel migration)			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Lamprey	Upstream migration (river lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Downstream migration (sea lamprey)		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Juvenile (ammocoete and transformer) brook and river lamprey habitat		N/A	N/A	N/A	N/A	N/A	N/A	N/A				
	Water quality	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Other fish species- Minnow, Stone loach and Three-spined stickleback			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Risk to WFD waterbody fish status			N/A	N/A	N/A	N/A	N/A	N/A	N/A				
Landscape and Visual Amenity		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N
Recreation		N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N

Key to Environmental Effects:

N/A	Outside implementation period
N	Negligible impacts are considered likely
	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 Designated Sites

Table 5.4 presents a summary of the potential impacts of the drought permit identified from the assessment of designated sites. The location of each of the designated sites discussed below is set out in **Figure 2.3**.

Table 5.4 Summary of Impacts of Drought Permit Implementation on Designated Sites

Feature	Impact	Significance of Impact
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Coed Llys-Aled SSSI	• The features for which the site is designated are not dependant on the Afon Aled.	**Negligible**
Coed Nant-y-Merddyn-Uchaf SSSI	• The features for which the site is designated are not dependant on the Afon Aled.	**Negligible**
Mynydd Hiraethog SSSI	• No water dependant features are located within the zone of hydrological influence	**Negligible**

5.3.4 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 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.

The Environment Agency[7] 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, phytobenthos, macroinvertebrate 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.

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

Table 5.5 Summary of Impacts of Drought Permit Implementation on Macrophytes

WFD Waterbody		Significance of Impact
Aled - above Deunant GB110066054930 Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Negligible**
Aled - Elwy to Deunant (GB110066059770) Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Minor**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Negligible**
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Negligible**
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Minor**

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 Waterbody		Significance of Impact
Aled - above Deunant GB110066054930 Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Minor**
Aled - Elwy to Deunant (GB110066059770) Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Moderate**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and/or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width. • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and/or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and/or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**

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 Waterbody		Significance of Impact
Aled - above Deunant GB110066054930 Curent status: High	• There is a risk of short-term deterioration in fish status of the water body due to the drought permit.	**Minor**
Aled - Elwy to Deunant (GB110066059770) Curent status: High	• There is a risk of short-term deterioration in fish status of the water body due to the drought permit.	**Moderate**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Minor**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Minor** (river & sea lamprey)
	• Loss of juvenile habitat as a result of reduced river levels.	**Minor**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Minor**
Other species	• Increased mortality due to habitat loss.	**Minor**
Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Minor**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Minor** (river & sea lamprey)
	• Loss of juvenile habitat as a result of reduced river levels.	**Minor**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Minor**
Other species	• Increased mortality due to habitat loss.	**Minor**
Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Moderate**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Moderate**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Moderate** (river lamprey) **Minor** (sea lamprey)

WFD Waterbody		Significance of Impact
	• Loss of juvenile habitat as a result of reduced river levels.	**Moderate**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Moderate**
Other species	• Increased mortality due to habitat loss.	**Minor**

Phytobenthos

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

Table 5.7 Summary of Impacts of Drought Permit Implementation on Phytobenthos

WFD Waterbody		Significance of Impact
Aled - above Deunant GB110066054930 Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Negligible**
Aled - Elwy to Deunant (GB110066059770) Curent status: Good (overall status)	• There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	**Minor**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Phytobenthos	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Negligible**
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Phytobenthos	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Minor**
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Phytobenthos	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Minor**

5.3.5 Invasive Species

Table 5.8 presents a summary of the potential impacts of the drought permit identified from the assessment of invasive and non-native species.

Table 5.8 Summary of Impacts of Drought Permit Implementation on Invasive Species

Feature	Impact	Significance of Impact
Reaches 1 – 3		
New Zealand pigmyweed *Crassula helmsii*	• The drought permit will result in a reduction in discharge from the reservoir and implementation is not anticipated to increase the range of New Zealand Pigmy weed within the Aled catchment	**Negligible**

5.3.6 Landscape, Heritage and Recreation

Table 5.9 presents a summary of the potential impacts of the drought permit identified from the assessment of landscape and recreation.

Table 5.9 Summary of Impacts of Drought Permit Implementation on Landscape and Recreation

Feature	Impact	Significance of Impact
Reaches 1 – 3		
Landscape	• Flows during drought conditions will naturally be low therefore the implementation of the drought permit is not expected to lead to any material additional landscape and visual amenity impacts	**Negligible**
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**

6 ALED ISAF DROUGHT PERMIT – MITIGATION

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

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 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 both 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 DO) 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[8] 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 Aled Isaf 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.

[8] 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 order / 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 2020)
    - Drought supply-side and drought order / permit options from other neighbouring water company Drought Plans, Natural Resources Wales Drought Plan
    - National Policy Statements for Wastewater and Renewable Energy Infrastructure
- Environmental monitoring before, during and after drought permit implementation (see Section 10).

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 Aled Isaf 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 Aled Isaf Reservoir.

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

Drought options from other neighbouring water company Drought Plans and Natural Resources Wales Drought Plans

No cumulative schemes have been identified for assessment.

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 Environmental Monitoring Plan (EMP) which is presented in Section 10 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 ALED ISAF 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 Aled Isaf drought permit meets the requirements of Section 5.2 (Monitoring) and informs the requirements of Section 5.3 (Mitigation) of 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 Section 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 (in relation to any proposals that may affect any SACs, SPAs, NNRs, SSSIs or RAMSAR sites) 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 investigating, 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
Fish (including salmon, brown trout, lamprey and eel) **Reach 3**	Reduction in spawning and juvenile survival due to habitat loss. Increase in mortality due to habitat loss. Delays and potential cessation of adult salmon and sea trout migration due to reduced flows. Delays and potential cessation of downstream adult eel migration due to reduced flows.	Fish populations are well understood as a result of recent NRW and Welsh Water monitoring[9]. Surveys to be repeated every three years Monitoring sites are located at: Reach 3 – NRW Site 1 Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. One site in each of the impacted reaches. To complement any existing NRW monitoring, in discussion with NRW.	Electric-fishing surveys to monitor fish populations at one site in each of the impacted reaches. One site in each of the impacted reaches. Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. One site in each of the impacted reaches. 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. • Identification of key	No fish population surveys are advised during drought as this may cause further stress. Additional walkovers, if situation is expected to deteriorate in stream sections known to contain high fish densities, spawning, nursery and cover habitats. Record extent of exposed marginal habitats, spawning habitats, bed substrates and estimates of overlaying silt cover. 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 the drought. Targeted fish passage	Targeted installation of woody debris features to provide fish with the habitat required to support feeding and development (growth). If the results of the walkovers deem spawning gravels to be at risk to siltation, the following mitigation action/s may be undertaken: • Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)[10] • Targeted installation of woody debris features to increase localised flow velocity/scour at impacted spawning gravels (to aid sediment transport and increase	Two years of annual post-drought fish population surveys at baseline monitoring sites (corresponding with a control and impact site/s) to determine any changes in population dynamics both temporally and spatially. Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. One site in each of the impacted reaches. 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. Walkover of key spawning	Welsh Water

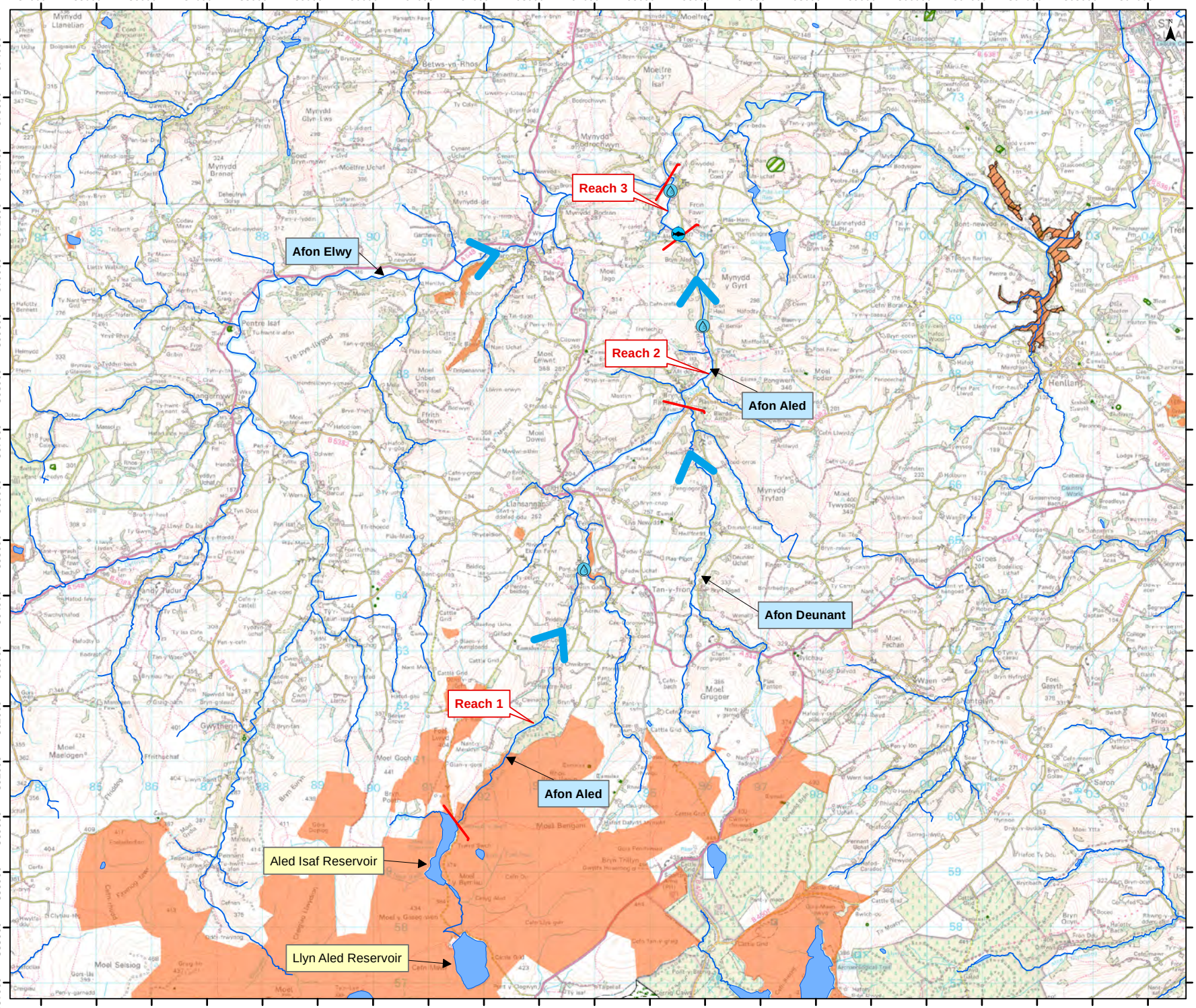
[9] Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018
[10] Wild Trout Trust Habitat Management Sheet – Gravel Cleaning http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf

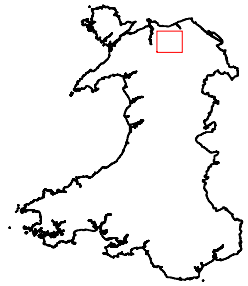
Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
			structures which may provide a barrier at lower flows. Approximation of the number of each fish species (e.g. 10s, 100s) in each ponded reach, where safe and practical to do so. 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.	assessment of barriers /obstructions to fish passage and any associated fish passes should be undertaken to ascertain if they pose an increased risk to the free movement of fish during key migration periods, i.e. during juvenile eel migration (spring/summer). Frequency of fish passage assessments to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of 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.	water depth for spawning depth) If the results of the walkovers deem important habitats to be at risk to exposure/ reduction (in extent), the following mitigation action/s may be undertaken: • Targeted installation of woody debris features to increase flow heterogeneity/scour and marginal cover in shallow areas of the channel[11] • Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels. • Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover	locations recording the number of redds potentially affected, undertaken during the winter spawning period. Record extent of exposed marginal habitats, spawning habitats, composition of the bed substrate and estimates of overlaying silt cover. If the results of the walkovers deem spawning gravels to have suffered from siltation, the following mitigation action/s may be undertaken: Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)[12] Targeted installation of woody debris features to: • increase flow heterogeneity /scour and marginal cover in shallow areas of the channel[13] • increase localised flow velocity/scour at impacted spawning gravels (to aide	

[11] Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf
[12] Wild Trout Trust Habitat Management Sheet – Gravel Cleaning http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf
[13] Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf

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)	
					surveys. Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW. 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. Modify any impacted fish passes (where possible) to ensure passage is maintained during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage). Consider 'Trap & Transport' of concentrated abundances	sediment transport and increase water depth for spawning depth) If the results of the walkovers deem important habitats to be at risk to exposure/ reduction (in extent), the following mitigation action/s may be undertaken: • Targeted fish passage assessment of barriers /obstructions to fish passage and any associated fish passes should be undertaken to ascertain if they pose an increased risk to the free movement of fish during key migration periods, i.e. during juvenile eel migration (spring/summer). • Modify any impacted fish passes (where possible) to ensure passage is achievable during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage). Where fish passage is not currently provided at a barrier, investigate appropriate methods of improving passage (e.g. fish passage	

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)	
					of migrating fish accumulated below impassable barrier/s to spawning grounds upstream of the impacted reach (where environmental parameters such as dissolved oxygen and temperature allow). Alternatively, mitigation should seek to protect any populations 'trapped' as a result of the barrier/s until flows increase for example by using aeration (if dissolved oxygen levels are low) or preventing predation (see Increased Mortality impact mitigation actions outlined above). Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels.	design and installation).	





Legend

- Hydrological Reach
- Water Courses
- Reservoir
- Spot Flow & Water Quality Survey Site
- Fish Survey
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments
- Direction of Flow

RICARDO

Dŵr Cymru Welsh Water

1:65,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Monitoring: 8012-2 Reduce the statutory compensation release from Aled Isaf Reservoir

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 Aled Isaf drought permit. If granted and implemented, the drought permit would enable Welsh Water to temporarily reduce by 1 Ml/d the required regulation release from Aled Isaf Reservoir to the Afon Aled whenever abstraction is required during the residual flow period of 1 February to 31 May, together with a reduction of 1M/d in the residual flow condition at Bryn Aled intake. During the period of 1 June to 31 January, the drought permit involves a proposed reduction of 2Ml/d in the regulation release rate from Aled Isaf Reservoir whenever abstraction is taking place and residual flow at Bryn Aled is below 29.5Ml/d. This would conserve the longevity of total reservoir storage for regulation releases to the Afon Aled for abstraction at the Bryn Aled intake.

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/order (Stage 2).

The hydrological / hydrogeological impact assessment identified a **minor-moderate** impact on flows in the Afon Aled and a minor positive impact on Llyn Aled Reservoir and Aled Isaf Reservoir.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified Coed Llys-Aled SSSI, Coed Nant-y-Merddyn-Uchaf SSSI, Mnydd Hiraethog SSSI, WFD Status and Community Assessment / Environment (Wales) Act Section 7 Species, and landscape and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that there are **minor-moderate** impacts on aquatic ecology, specifically: moderate impacts on fish, and minor impacts on macroinvertebrates, macrophytes and phytobenthos. Impacts on designated sites have been assessed as negligible.

No cumulative effects of implementing the drought permit with other 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 Aled Isaf.

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at Aled Isaf, 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** in the absence of mitigation.

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 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 a compensation release from Aled Isaf of 2.27Ml/d (daily average) and seasonal (July to October) fisheries releases of between 2.0 to 3.8Ml/d, as per existing arrangements. The baseline also includes the continuation of daily abstraction at Bryn Aled intake on Afon Aled for potable supply, supported by regulation releases from Aled Isaf Reservoir as required to maintain seasonal residual flow values at Bryn Aled. This represents normal operating arrangements during a typical summer / autumn period. The assessed drought permit involves the continuation of Welsh Water's abstraction at a maximum daily rate of 16Ml/d, with a reduction of 2Ml/d in both the residual flow conditions at Bryn Aled intake and the regulation release rate required to support the downstream abstraction, during the period of 1 June to 31 January.. Seasonal fisheries releases are assumed to continue unchanged during the relevant months, and the compensation release rate is also unchanged under the drought permit.

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
- 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.

The abstraction of water is taken from the Afon Aled at the Bryn Aled intake and pumped 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.

B.1.2 Welsh Water's Proposed Drought Permit Operations

The drought permit involves a proposed reduction of 2Ml/d in the required regulation release rate from Aled Isaf Reservoir to the Afon Aled whenever abstraction is required during the residual flow period of 1 June to 31 January, together with a reduction of 2M/d in the residual flow condition at Bryn Aled intake. This would conserve the longevity of total reservoir storage for regulation releases to the Afon Aled for abstraction at the Bryn Aled intake. The drought permit scheme will potentially influence the downstream Afon Aled.

The timing of the reduction in the regulation release is most likely to occur during the late summer to early winter period (within the period 1 September to 31 January). This is based on modelling of the two Aled reservoirs' performance under normal operating conditions, together with Welsh Water's experience of operating the source. Potential impacts on flow and water level have therefore been assessed using both summer (for September) and year round flow statistics (for October-January).

The assessment includes Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its 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. This tributary is relevant to the assessment of cumulative impacts with the Llyn Bran drought permit (8012-1; transfer of water from Llyn Bran to Afon Aled) (see Section B5).

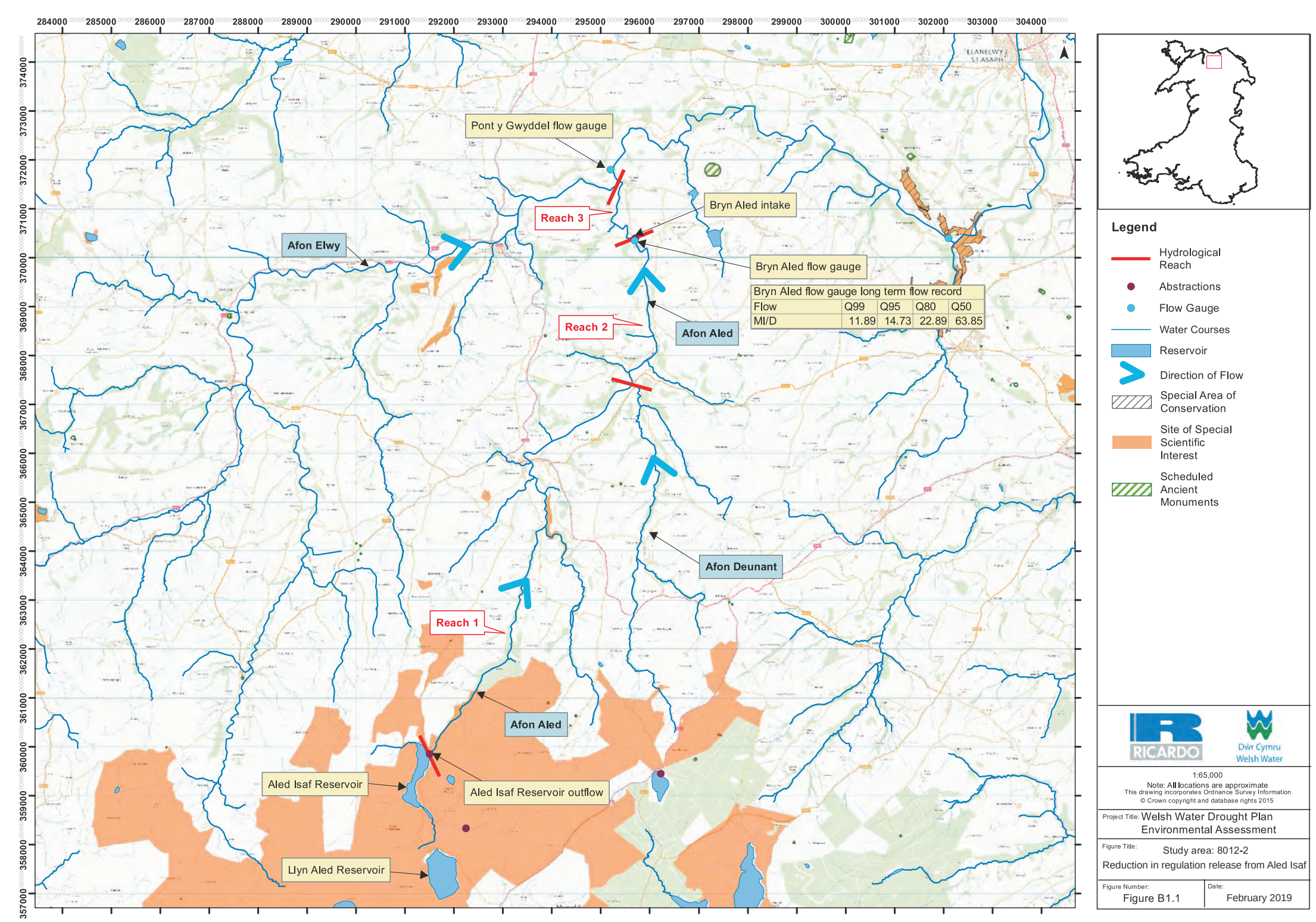
The physical environment includes consideration of hydrology and hydrodynamics; geomorphology; and water quality. The assessment has three key objectives:

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. Provide supporting technical information for the screening and assessment of sensitive physical environmental features.

This appendix is set out in the following sections:

Section B.2 Hydrological Impact
Section B.3 Physical Environment Assessment
Section B.4 Physical Environment Impact Summary
Section B.5 Cumulative Impacts

[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.


Pont y Gwyddel flow gauge
Reach 3
Bryn Aled intake
Afon Elwy
Bryn Aled flow gauge
Bryn Aled flow gauge long term flow record
Flow | Q99 | Q95 | Q80 | Q50
Ml/D | 11.89 | 14.73 | 22.89 | 63.85
Reach 2
Afon Aled
Afon Deunant
Reach 1
Afon Aled
Aled Isaf Reservoir
Aled Isaf Reservoir outflow
Llyn Aled Reservoir
LLANELWY / ST ASAPH
Legend
Hydrological Reach
Abstractions
Flow Gauge
Water Courses
Reservoir
Direction of Flow
Special Area of Conservation
Site of Special Scientific Interest
Scheduled Ancient Monuments
RICARDO
Dŵr Cymru Welsh Water
1:65,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
© Crown copyright and database rights 2015
Project Title: Welsh Water Drought Plan Environmental Assessment
Figure Title: Study area: 8012-2
Reduction in regulation release from Aled Isaf
Figure Number: Figure B1.1
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, where the maximum altitude reaches 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 20 km, flowing into the Clwyd Estuary and Liverpool Bay at Rhyl.

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 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-present
- Bryn Aled flow gauge; daily river flow data 1990-present.

In addition, Natural Resources Wales (NRW) measure river flow on the Afon Elwy, 300m

downstream of the confluence with the Afon Aled[2]:

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

The reference conditions of Llyn Aled Reservoir, Aled Isaf 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.

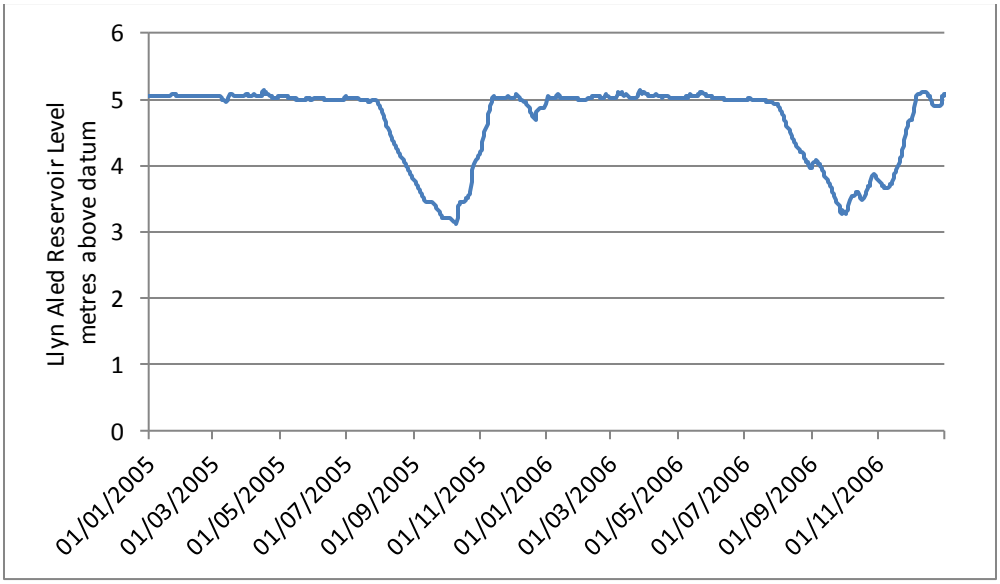
Table B2.1 Summary of Recorded Mean Daily Reservoir Level in Llyn Aled Reservoir (January 1995 – December 1996 and February 2001 – December 2015)

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.

[2] The gauge is a full range gauging station and is therefore used for flow and resource assessments throughout its range.

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



Aled Isaf Reservoir

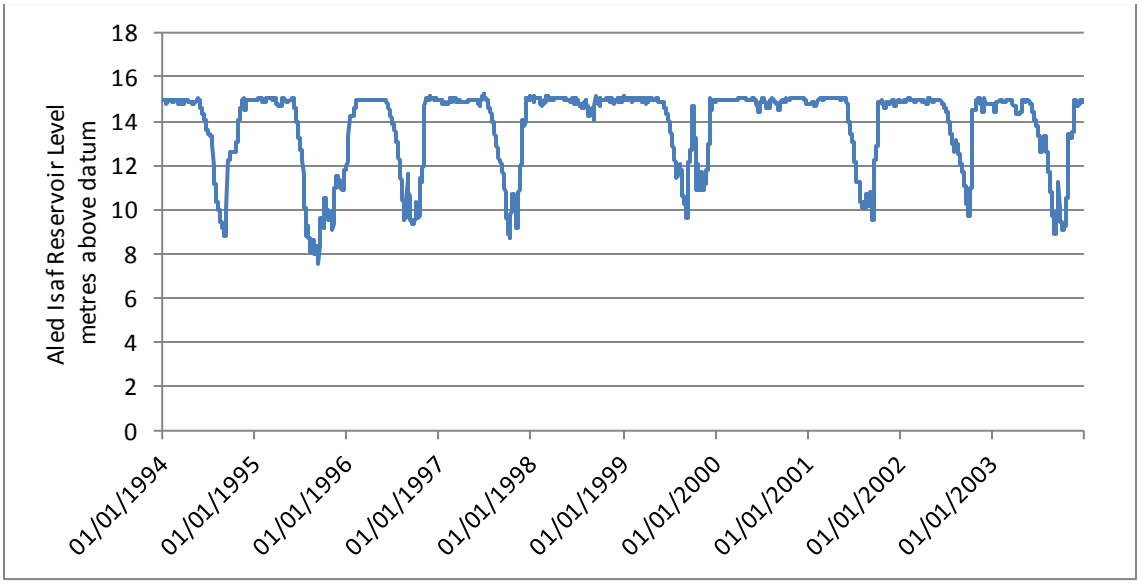
Top water level at Aled Isaf (at which overflow occurs) is at about 15 m. Typically reservoir levels in Aled Isaf range from around 8 m up to 15 m (see also **Table B2.2**). The lowest levels of 2m are understood to be due to reservoir drawdown for dam maintenance works in 1992/93; lowest levels experienced during the critical drought period of 1995/1996 were around 8m. The Section 20 agreement requires release from Lyyn Aled to maintain levels in Aled Isaf between 8 and 10m.

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 B2.3 illustrates the typical drawdown patterns in Aled Isaf over a ten-year period 1994– 2003.

Figure B2.3 Aled Isaf Reservoir Level (1 January 1994 to 31 December 2003)



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 B2.3,** and the flow duration curve is shown in **Figure B2.5**. A hydrograph of flows in a typical dry year (1996) is shown in **Figure B2.6**.

Table B2.3 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 B2.5 Flows in the Afon Aled at Bryn Aled Gauging Station (1990-2015)

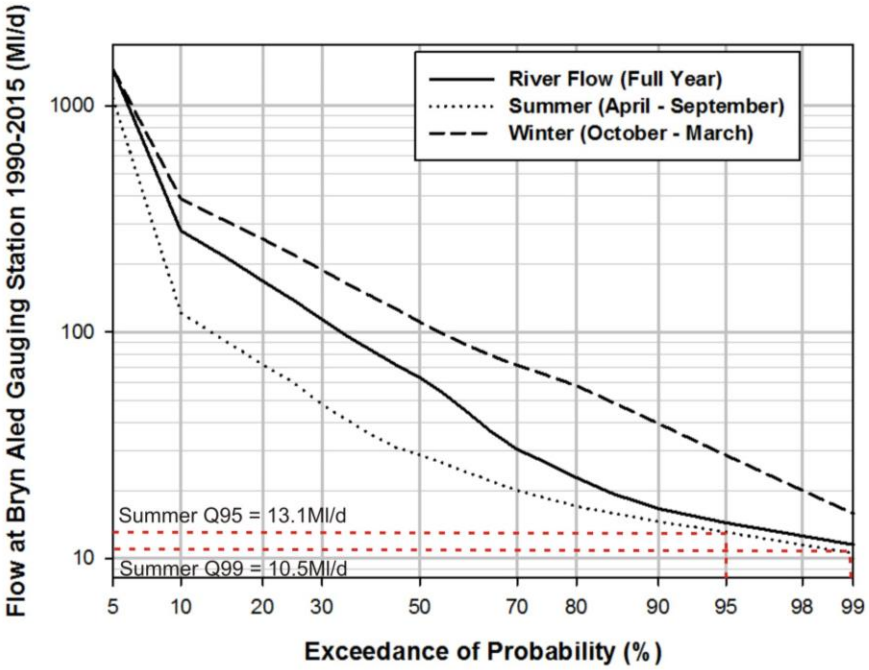
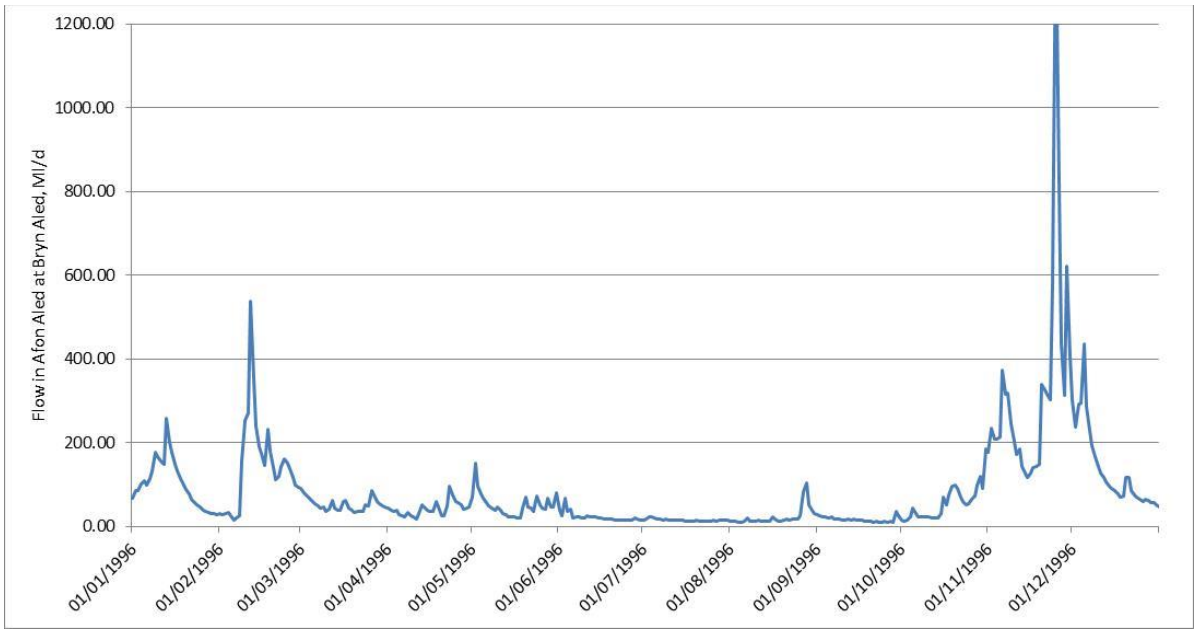


Figure B2.6 Afon Aled at Bryn Aled Gauging Station (1996)



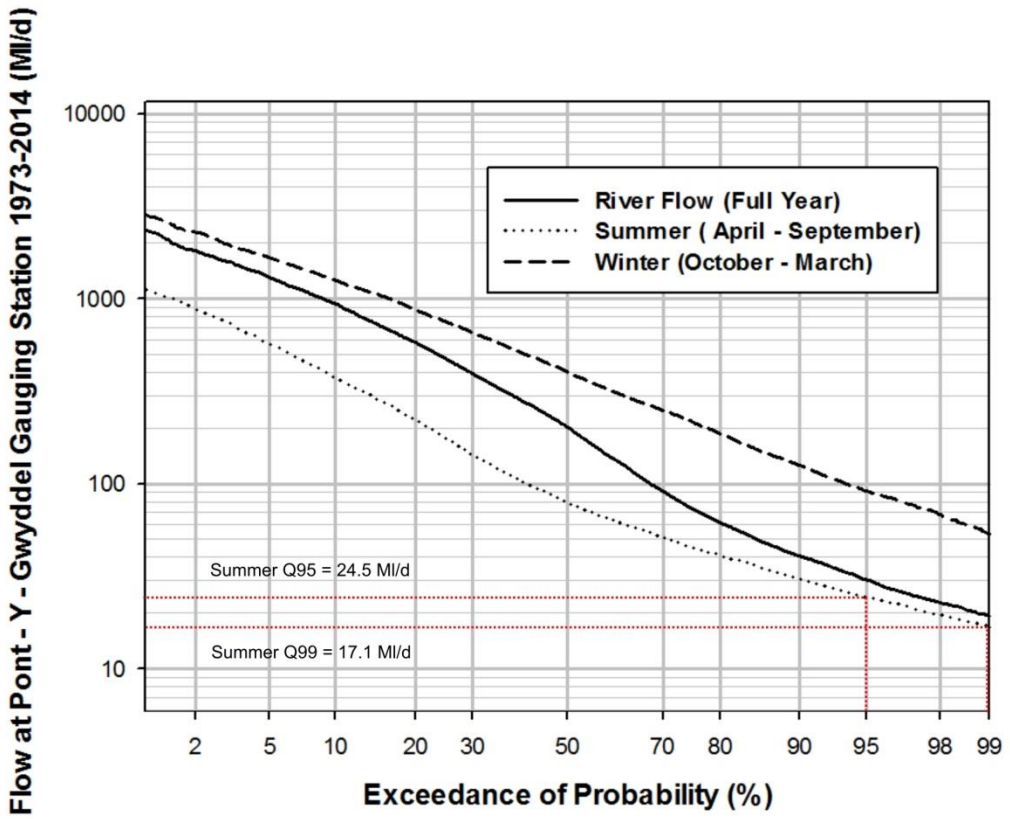
Afon Elwy

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 B2.4** gives the key flow statistics for this location, and the flow duration curve is shown in **Figure B2.7**.

Table B2.4 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 B2.7 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 B2.5**.

Table B2.5 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

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 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 comprises three 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. 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 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.

- 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 hydrological 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 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 a reduction of up to 2Ml/d in the regulation release from Aled Isaf Reservoir represents approximately a 8.2% reduction in the

Q_{95} low flow statistic at Afon Elwy, and a 11.6% reduction in the Q_{99} extreme low flow statistic. The impact of this drought permit downstream of the confluence with the Afon Elwy is therefore considered as minor, and 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 two reservoirs and three separately identified river reaches of the Afon Aled, as summarised in **Tables B2.6** and **B2.7** at the end of this section.

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

B.2.2.2 Hydrological Impact Assessment

Llyn Aled Reservoir

No changes to the operation of Llyn Aled Reservoir are proposed as part of this drought permit. There may be a very marginal reduction in the volume of water required to be transferred to Aled Isaf reservoir, to support storage in that reservoir during the drawdown period, as storage in Aled Isaf Reservoir would be higher due to the reduced regulation releases. This would lead to a marginal increase in levels / storage in Llyn Aled, relative to the position without the drought permit. This would be considered as a small beneficial impact and has not been assessed further.

Aled Isaf Reservoir

The impact of the reduced rate of regulation release on Aled Isaf Reservoir would be an increase in levels / storage, relative to the position without the drought permit, due to the reduced outflow which would help to conserve water in storage. This would be considered as a small beneficial impact and has not been assessed further.

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

During a hydrological drought in the summer and autumn period, a range of controlled releases will be made from Aled Isaf Reservoir. Compensation releases will be to the licensed requirement of 2.27Ml/d. Regulation releases are assumed to be either 9.2Ml/d (the fixed capacity of the small pump at Bryn Aled intake) or greater, to a limit of 16Ml/d (the capacity of the bigger, variable speed pump at Bryn Aled intake), although Welsh Water are able to turn the pumps on and off, and do so according to energy tariffs, so the release required may be less than 9.2 Ml/d at times. In addition, during summer and early autumn (1 July to 16 October) a further release is made for fisheries management as specified in the Section 20 agreement, either as a continuous release or in a varied release pattern as specified by the

NRW fisheries officer. Therefore, in a water resources drought without a drought permit, the minimum controlled release would typically be 15.27Ml/d (1 July to 15 September), 13.47Ml/d (16 September to 16 October) and 11.47Ml/d outside this period, providing that abstractions are taking place. The maximum controlled release would be up to 22Ml/d (1 July to 15 September), or 18.27Ml/d (16 September to 30 June).

The drought permit reduction in the regulation release rate from Aled Isaf Reservoir will reduce flow in the downstream Afon Aled by 2Ml/d (1 September to 31 January). In Reach 1 in the summer period (September), this reduction would reduce the flow in the Afon Aled by about 9-15% immediately downstream of the Aled Isaf Reservoir outfall, providing abstraction is taking place and depending on the daily volume of regulation releases made by Welsh Water. During low flow periods there will be minor additional inflow from the catchment area. The hydrological impact of this drought option on Reach 1 is, therefore, considered to be **minor** during the summer month of September.

During the autumn/early winter period (October to January), at times when abstractions are still taking place and regulation releases are still required to meet the residual flow requirement at Bryn Aled, the drought permit will continue to reduce flow in the Afon Aled by 2 Ml/d (to 31 January). This represents a reduction in flow of between 11-17%, and therefore the hydrological impact of this drought option is considered to be **minor** during the winter months also.

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. During low flow periods there will be minor additional inflow from the catchment area and the one significant tributary (Afon Deunant), such that the percentage reduction in flow due to the reduced compensation release is as Reach 1 or lower.

Based on flow apportionment by catchment area (see **Table B2.5**), flow accretion in Reach 2 would be approximately 66% of the flow at Bryn Aled, so that the additional flow would be estimated at around 8.6Ml/d (summer Q_{95}) and 6.9Ml/d (summer Q_{99}). Depending on the volume of regulation releases made by Welsh Water, low flows in Reach 2 would be around 18.4Ml/d to 30.7Ml/d. A 2Ml/d reduction in these flows due to reduced regulation releases together with a corresponding reduction in the residual flow value (during the residual flow period of 1 February to 31 May, if abstraction is taking place) would reduce the flow in the Afon Aled by about 6-11%.

The hydrological impacts associated with a reduction in regulation release will include a minor reduction in wetted channel width and wetted channel depth upstream of the Bryn Aled intake. The hydrological impact of this drought option on Reach 2 is considered to be **minor** during the summer month of September.

During the early autumn and winter period, the year round median flow statistic (Q_{50}) at Bryn Aled is 62.9Ml/d, which is well above the residual flow value and so regulation releases would

not be required at the Q_{50} flow threshold. At low flows, represented by the year round Q_{95} flow statistic of 14.4Ml/d at Bryn Aled (estimated flow accretion of 9.5Ml/d in Reach 2), flows in reach 2 would be around 21Ml/d to 27.8Ml/d depending on the regulation release made from Aled Isaf Reservoir to Reach 1 when abstractions are taking place. The reduction in regulation release of 2Ml/d, if applicable, represents a reduction of around 7-9% and therefore the hydrological impact of the drought permit on Reach 2 would be considered **negligible** in the winter months (October to January).

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

Following the abstraction of the regulation release water at the Bryn Aled intake, flow in the downstream Afon Aled is lower in upper Reach 3 than in lower Reach 2. In upper Reach 3, measured flow data are available from the Bryn Aled flow gauge. From the long term flow record, summer low flow conditions (summer Q_{95}) are approximately 13.1Ml/d, with extreme summer low flows (summer Q_{99}) of around 10.5Ml/d.

A 2Ml/d reduction in these flows due to reduced regulation releases and a reduction in the residual flow value (during the residual flow period of 1 February to 31 May, if abstraction is taking place) would be a 15% reduction in low summer flows and a 19% reduction in extreme low summer flows throughout Reach 3. The hydrological impact of this drought option on Reach 3 is, therefore, considered to be **moderate** in the summer month of September.

The year round median and low flow statistics at Bryn Aled are Q_{50}=62.9Ml/d and Q_{95}=14.4 respectively. Regulation releases would not be required at the Q_{50} flow threshold and therefore there would be no flow reduction due to the drought permit. A reduction of 2Ml/d, at times when abstractions are taking place, would represent a percentage reduction of up to 14% in the Q_{95} year round low flow value. The hydrological impact of this drought option on Reach 3 is, therefore, considered to be **minor** in the winter months of October to January inclusive.

B.2.2.3 Hydrological Impact Summary

The two Aled catchment reservoirs and three downstream river reaches have been considered. There is a minor beneficial impact of this drought permit on the two reservoirs, and the impact on the three river reaches ranges from **minor** to **moderate** (September) and from **negligible** to **minor** (October - January). The three impacted reaches are shown in **Tables B2.6** to **B2.7** establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

Table B2.6 Hydrological Reaches identified in the Study Area – Summer Impact (September)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact – Summer
		Upstream	Downstream		Summer Q_{95}	Summer Q_{99}	
Llyn Aled Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor Beneficial**
Aled Isaf Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor Beneficial**
1	Afon Aled	Aled Isaf Reservoir Outflow	Afon Deunant confluence	10.1km	Up to 15%	Up to 15%	**Minor**
2	Afon Aled	Afon Deunant confluence	Bryn Aled intake	3.0km	Up to 11%	Up to 11%	**Minor**
3	Afon Aled	Bryn Aled intake	Afon Elwy confluence	1.6km	15%	19%	**Moderate**

Table B2.7 Hydrological Reaches identified in the Study Area – Winter Impact (October – January)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact – Winter
		Upstream	Downstream		Year round Q_{50}	Year round Q_{95}	
Llyn Aled Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor Beneficial**
Aled Isaf Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor Beneficial**
1	Afon Aled	Aled Isaf Reservoir Outflow	Afon Deunant confluence	10.1km	0%	Up to 17%	**Minor**
2	Afon Aled	Afon Deunant confluence	Bryn Aled intake	3.0km	0%	Up to 9%	**Negligible**
3	Afon Aled	Bryn Aled intake	Afon Elwy confluence	1.6km	0%	14%	**Minor**

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

Geomorphological data has been provided by River Habitat Survey (RHS) and supplemented, where needed, by extant aerial imagery. Four RHS surveys are located within Reach 1 (Survey ID: 35175, 35253, 432, 6432) and one RHS survey in Reach 2 (Survey ID: 3432). No RHS surveys are located within Reach 3.

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

Reach 1 is 10.1km and falls 255m, a gradient of 1.45°, the reach is fairly sinuous. The upper part of the reach is formed in a confined valley, with little floodplain, this increases downstream towards the town of Llansannan. Surrounding land-use is dominated by woodland and farmland. Riparian tree cover is semi-continuous to continuous along the reach.

Banks within the reach, recorded by RHS surveys are steep, however areas of shallower bank were also observed using extant aerial imagery, for example at the ford within the reach. Banks are dominantly comprised of Earth, however areas of brick, cobble and gravel/sand were also observed. Bank reinforcement was observed at RHS Site 432. Several areas of poaching were recorded by the RHS surveys and using extant aerial imagery.

Flow within the channel was dominated by almost laminar flow (Survey ID 432) and rippled (Survey ID 6432), however some flow variation was also observed and areas of smooth flow and up welling were recorded. Bed substrate was recorded as unconsolidated at Survey ID 35175 and 35253, and given the other surveys is most likely dominated by cobble (Survey ID 432) or gravel/pebble (Survey ID 6432), however areas of sand and boulder were also observed.

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

Reach 2 is 3.0km and falls 23m, a gradient of 0.44°, the reach is fairly sinuous. Surrounding land-use is dominated by farmland and riparian tree cover is semi-continuous to continuous along the reach. Urban land-use is limited to small villages such as Pont Nant Mastyn and Tan-y-graig.

Banks within the reach, recorded by the RHS survey are gentle (<45°). Banks are comprised of earth, however areas of cobble, bedrock and brick were also observed. Some bank reinforcement was also observed. In the location of bedrock and brick, steeper banks are assumed. No areas of poaching were observed during the RHS surveys.

Flow within the channel was dominated by upwelling (40%), however areas of rippled, smooth and chaotic flow were also observed. Bed substrate was dominated by cobble (50%), however areas of boulder, gravel/pebble and silt were also observed.

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

No RHS surveys have been undertaken in this reach. Conditions are assumed to similar to the upstream reaches. The reach is 1.6km in length, and falls 9m, a gradient of 0.32°. Surrounding land-use is dominated by farmland.

Given the riparian vegetation, it is assumed the banks are comprised of earth. Bank steepness is unknown. Flow within the channel is assumed to be varied, given the information from Reach 2. Bed substrate is likely to be dominated by cobble to gravel grade.

Assessment

Given the likely hydrological impacts, some variation in geomorphological functioning is expected.

Wetted width may change due to the implementation of the drought permit, this is likely to be more severe in shallower sections of the channel. Wetted width change may impact habitat availability. Impacts are assessed as minor in Reach 1 for summer and winter. In Reach 2, impacts are assessed as minor in summer and negligible in winter. In Reach 3, impacts are assessed as minor in winter and minor in summer, as the location of the shallower sections of channel are unknown.

Due to the implementation of the drought permit, there may be increased deposition of fine grained sediment, especially in areas of pooling, whether natural or behind weirs. The reaches are dominated to coarser grained substrate, which will not be in transport during a drought. Overall, the risk is assessed as negligible for all the reaches during summer and winter, as there are no areas of natural pooling or weirs within the channel. Further, the high gradients and upland nature of the reaches will allow finer grained material to be transported during a drought. Minor deposits of silt were recorded (<10%) in Reach 1, however as this is minimal, it is assumed that any silt deposited during the drought option will be transported when normal flows resume.

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 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 Section 5 of the main report), 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 following UKTAG evidence 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.

NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact. In the Afon Aled catchment, within the extent of influence of the Aled Isaf drought permit there are three NRW water quality sampling sites, as detailed in Table (**B3.1 and Figure B3.1**)

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
1	Afon Aled downstream Llyn Aled Isaf	2666	SH9152059870
1	Afon Aled upstream of Afon Deunant	2682	SH9559067380
3	Afon Aled Pont Yr Aled	2688	SH9552070450

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

Water quality analysis for this reach (affected by a minor hydrological impact) has been undertaken based on the data available at the water quality monitoring sites listed in **Table B3.1.**

pH and Temperature

The average pH and maximum temperature for the three sites in Reach 1 are summarised in **Table B3.2.**

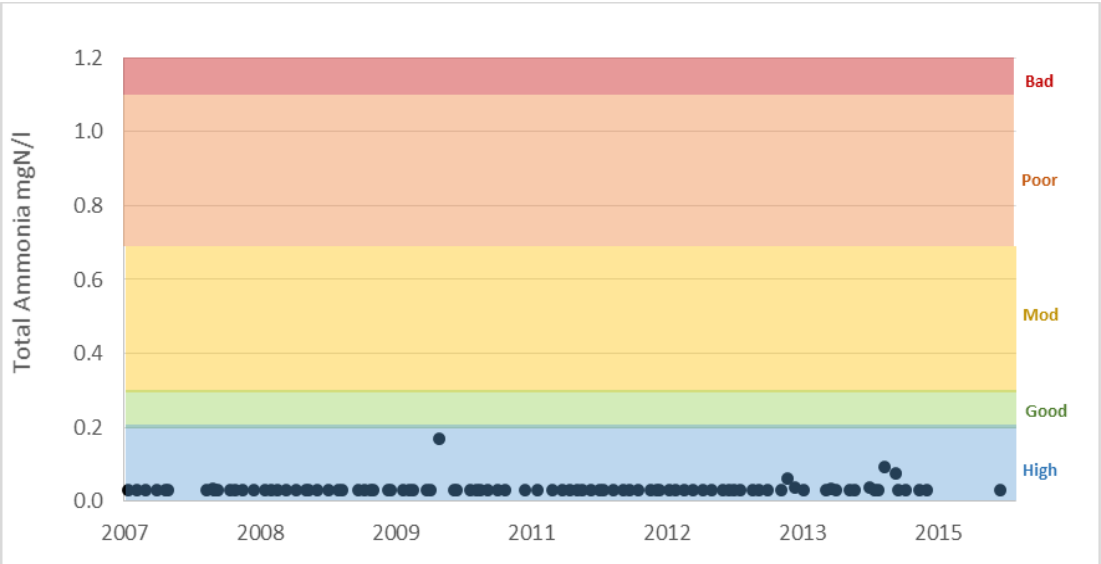
Table B3.2 pH and Maximum Temperature at NRW Water Quality Sampling Points

Site Name	Average pH	Maximum temperature
Afon Aled downstream Llyn Aled Isaf	7.4	18.8
Afon Aled upstream of Afon Deunant	7.6	17.9

Total Ammonia Concentrations

Total ammonia concentration data from Afon Aled downstream Llyn Aled Isaf were reviewed and presented in **Figure B3.2** against the relevant WFD standards for a upland low alkalinity river.

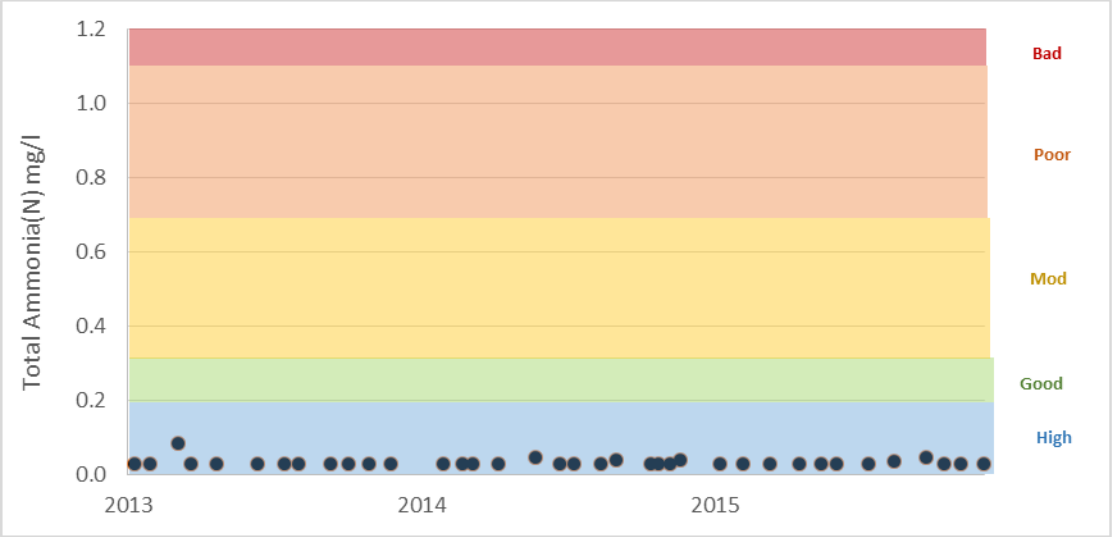
Figure B3.2 Total Ammonia Concentration at Afon Aled Downstream Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands



Total ammonia concentration measurements at Afon Aled downstream Llyn Aled Isaf were compliant with the WFD standard to support high status (0.2 mg/l) for fish and invertebrates for an upland low alkalinity river.

Total ammonia concentration data from Afon Aled upstream of Afon Deunant were reviewed and presented in **Figure B3.3** against the relevant WFD standards for a upland low alkalinity river.

Figure B3.3 Total Ammonia Concentration at Afon Aled Upstream of Afon Deunant, Incorporating Appropriate WFD Status Bands

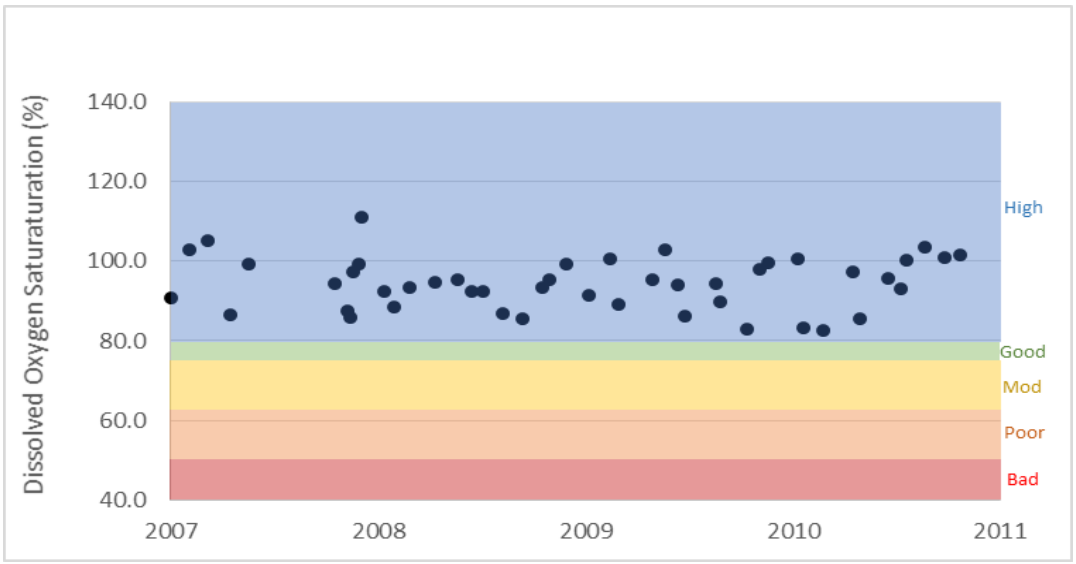


Total ammonia concentration measurements at Afon Aled upstream of Afon Deunant were compliant with the WFD standard to support high status (0.2 mg/l) for fish and invertebrates for an upland low alkalinity river.

Dissolved Oxygen Saturation

Dissolved oxygen saturation data from Afon Aled downstream Llyn Aled Isaf were reviewed and presented in **Figure B3.4** against the relevant WFD standards for a upland low alkalinity river.

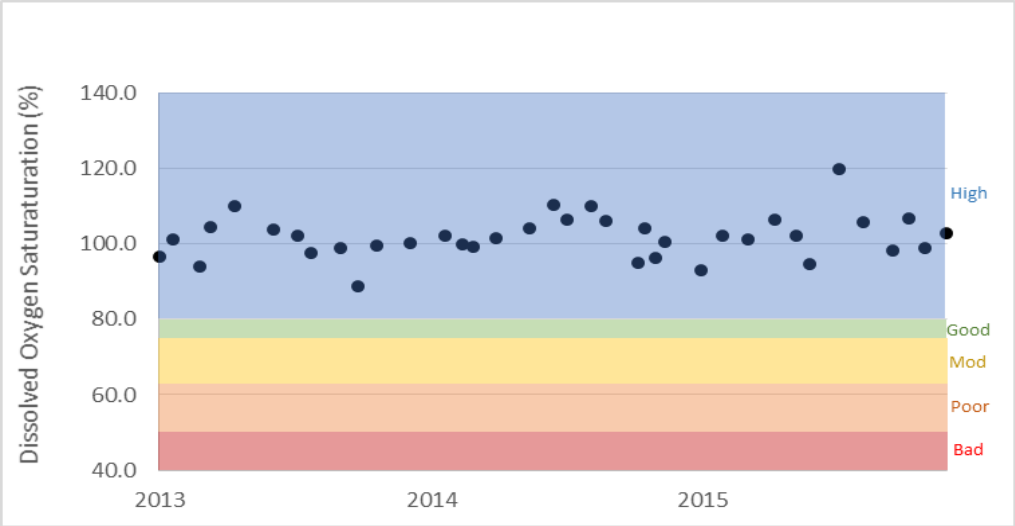
Figure B3.4 Dissolved Oxygen Saturation at Afon Aled downstream Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at Afon Aled downstream Llyn Aled Isaf were compliant with the WFD standard to support high status (80 % saturation) for fish and invertebrates for an upland low alkalinity river.

Dissolved oxygen saturation data from Afon Aled upstream of Afon Deunant were reviewed and presented in **Figure B3.5**. against the relevant WFD standards for a upland low alkalinity river.

Figure B3.5 Dissolved Oxygen Saturation at Afon Aled Upstream of Afon Deunant, Incorporating Appropriate WFD Status Bands



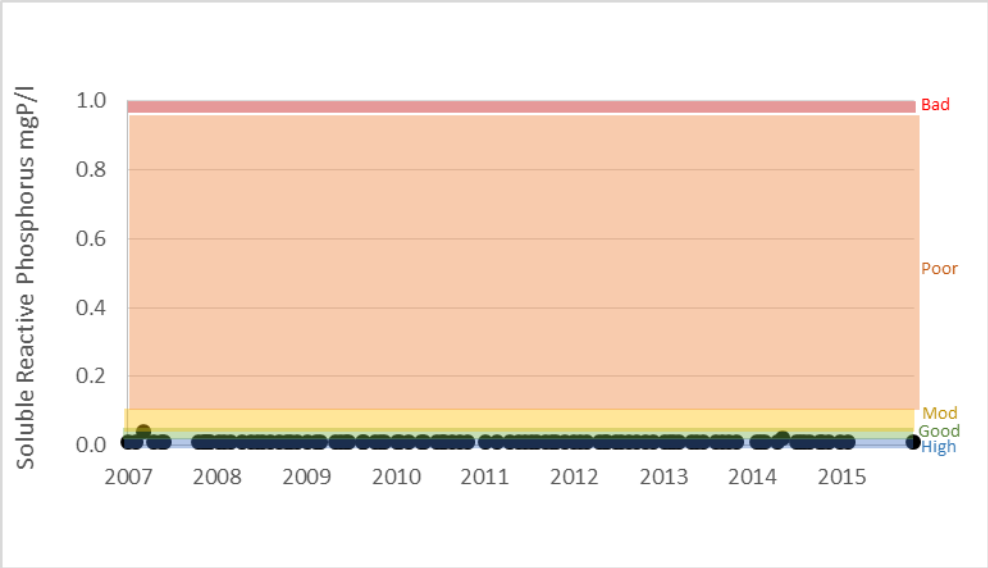
Dissolved oxygen saturation measurements at Afon Aled upstream of Afon Deunant were compliant with the WFD standard to support high status (80 % saturation) for fish and invertebrates for an upland low alkalinity river.

Soluble Reactive Phosphorus Concentrations

Soluble reactive phosphorus data from Afon Aled downstream Llyn Aled Isaf were reviewed and presented in **Figure B3.6** against the relevant WFD site specific standards provided by the EA[3].

[3] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

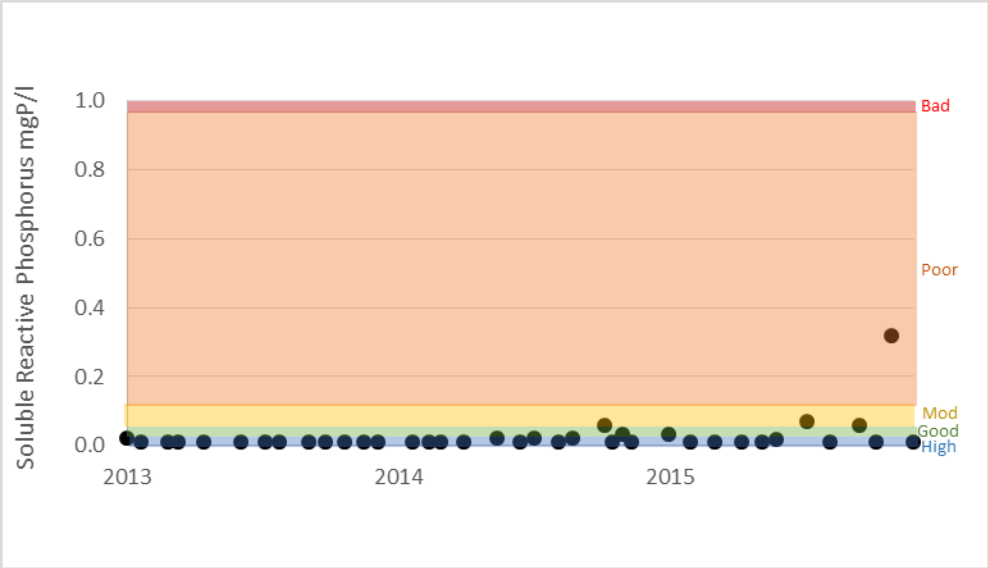
Figure B3.6 Soluble Reactive Phosphorus at Afon Aled Downstream Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands



Soluble reactive phosphorus concentrations at Afon Aled downstream Llyn Aled Isaf were consistent with the WFD standard to support high or good status (mgP/l) for fish and invertebrates for an upland low alkalinity river.

Soluble reactive phosphorus data from Afon Aled upstream of Afon Deunant were reviewed and presented in **Figure B3.7** against the relevant WFD site specific standards provided by the EA[4].

Figure B3.7 Soluble Reactive Phosphorus at Afon Aled upstream of Afon Deunant, Incorporating Appropriate WFD Status Band



Soluble reactive phosphorus concentrations at Afon Aled upstream of Afon Deunant were

[4] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

mostly consistent with the WFD standard to support high or good status (mgP/l) for fish and invertebrates for an upland low alkalinity river, occasionally falling short of this standard and crossing into the 'moderate' (3 instances) and respectively 'poor' (1 instance) status bands.

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

No water quality data was available in this reach (affected by a minor hydrological impact)

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

Water quality analysis for this reach (affected by a moderate hydrological impact) has been undertaken based on the data available at the water quality monitoring sites listed in **Table B3.1.**

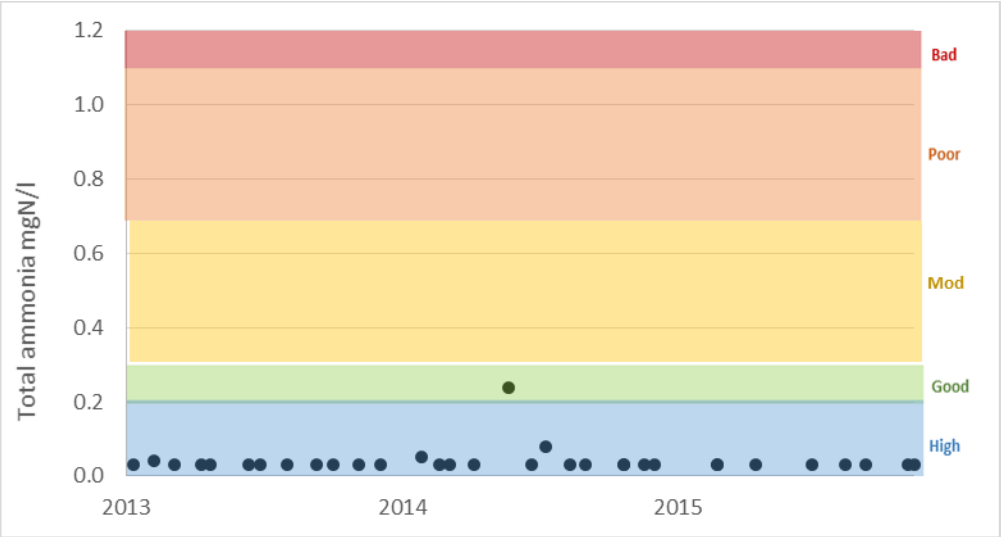
pH and Temperature

The average pH and maximum temperature measured at Afon Aled Pont Yr Aledwas 7.6 and 16.8 respectively.

Total Ammonia Concentration

Total ammonia concentration data from Afon Aled downstream Llyn Aled Isaf were reviewed and presented in **Figure B3.8**. against the relevant WFD standards for a upland low alkalinity river.

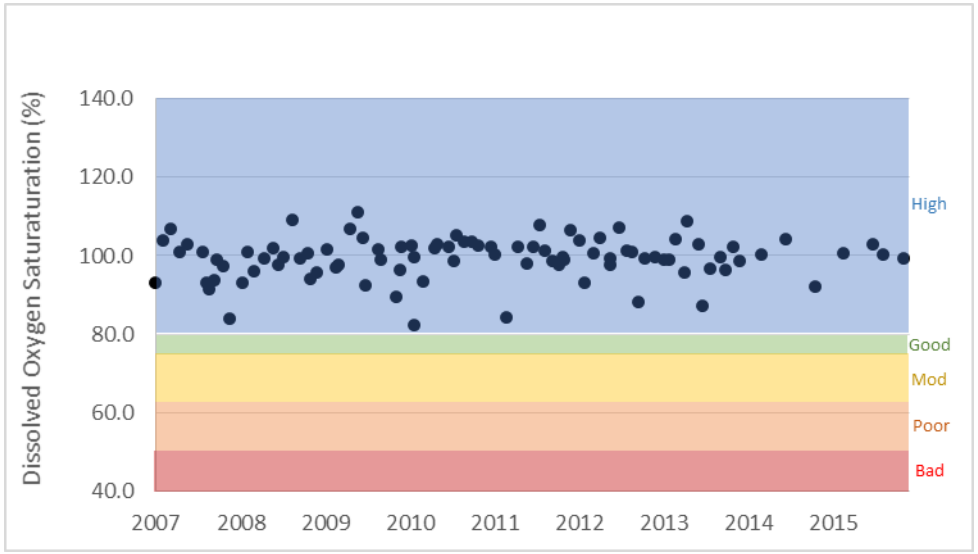
Figure B3.8 Total Ammonia Concentration at Afon Aled Pont Yr Aled, Incorporating Appropriate WFD Status Bands



Total ammonia concentration measurements at Afon Aled Pont Yr Aled were compliant with the WFD standard to support high status (0.2 mg/l) for fish and invertebrates for an upland low alkalinity river.

Dissolved oxygen saturation data from Afon Aled Pont Yr Aled were reviewed and presented in **Figure B3.9** against the relevant WFD standards for a upland low alkalinity river.

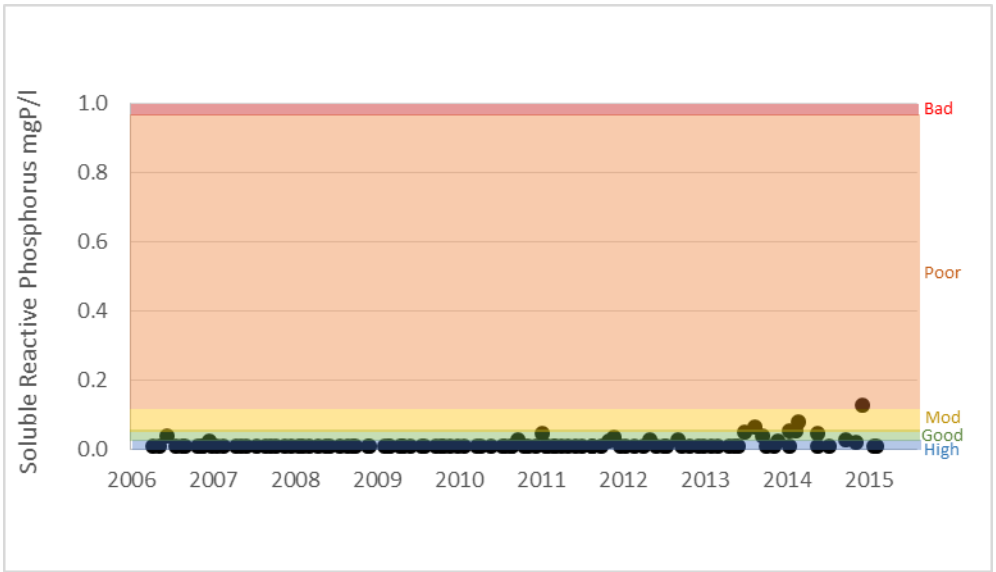
Figure B3.9 Dissolved Oxygen Saturation at Afon Aled Pont Yr Aled, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at Afon Aled Pont Yr Aled were compliant with the WFD standard to support high status (80 % saturation) for fish and invertebrates for an upland low alkalinity river.

Soluble reactive phosphorus data from Afon Aled Pont Yr Aled were reviewed and presented in **Figure B3.10** against the relevant WFD site specific standards provided by the EA[5].

Figure B3.10 Soluble Reactive Phosphorus at Afon Aled Pont Yr Aled, Incorporating Appropriate WFD Status Band



Soluble reactive phosphorus concentrations at Afon Aled Pont Yr Aled were consistent with the WFD standard to support high or good status (mgP/l) for fish and invertebrates for an upland low alkalinity river, occasionally falling short of this standard and crossing into the

[5] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

'moderate' (4 instances) and respectively 'poor' (1 instance) status bands.

Water Quality Summary

Assessment of risk of water quality deterioration as a result of the Aled Isaf drought permit has been undertaken considering the water quality as well as the nature of the hydrological impact within Reaches 1-3. Dissolved oxygen saturations and total ammonia concentrations were indicative of a high water quality status at all sites in Reaches 1 and 3. Therefore, the risk of water quality deterioration linked to total ammonia and dissolved oxygen is assessed as **low** for Reach 1 and Reach 3 and **assumed low** for Reach 2. SRP concentrations were largely compliant with the high/good WFD standards although some failures have been noted at two of the sites. Therefore, the risk of water quality deterioration linked to SRP concentration is assessed as **low** for Reach 1, **medium** for Reach 3 and **assumed medium** for Reach 2.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

No significant abstractions other than the three Welsh Water abstractions are located within the zone of influence: 24/66/5/5/S which abstracts 6.8 Ml/day; 24/66/5/6/S which abstracts 25.9 Ml/day and 24/66/5/7 which abstracts 27.3 Ml/day.

B.3.3.2 Water Quality Pressures

There is one sewage treatment works (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 B3.2 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	SH934306 5750	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	230	Negligible
CM0018901	Llansannan Sewage Treatment Works	SH937106 6010	Not Specified	0.0849	Not Specified	Not Specified	60	25	Negligible
CM0194701	Llansannan Ddol - sso	SH935006 5884	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 Isaf Reservoir 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 Isaf Reservoir Drought Permit

Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir	
River Flows in the Afon Aled *Minor impacts during the period September to January*	• Reduction in regulation releases could result in a flow reduction of up to 15% (September) or 17% (October - January)
Water quality in the Afon Aled *Low risk during September;*	• Low risk of deterioration linked to all determinands
Afon Aled (Reach 2) – downstream of Afon Deunant	
River Flows in the Afon Aled *Minor impacts during September; negligible impacts during the period October to January*	• Reduction in regulation releases could result in a flow reduction of up to 11% (September) or 9% (October - January)
Water quality in the Afon Aled *Low-medium risk during September;*	• Low risk of deterioration linked to total ammonia and dissolved oxygen; assumed medium risk for SRP
Afon Aled (Reach 3) – downstream of Bryn Aled	
Flows in the Afon Aled *Moderate impacts during September; minor impacts during the period October to January*	• Reduction in regulation releases could result in a flow reduction of up to 19% (September) or 14% (October - January)
Water quality in the Afon Aled *Low-medium risk during September;*	• Low risk of deterioration linked to total ammonia and dissolved oxygen; medium risk for SRP due to some recent standard failures

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Aled Isaf Reservoir 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 Isaf 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	8012-4 (Relax annual licences on Afon Aled and Plas Uchaf) This would potentially enable increased abstraction from Bryn Aled and therefore increased regulation releases from Aled Isaf Reservoir, potentially reducing reservoir levels in Aled Isaf Reservoir but with some relative benefit to the downstream watercourse due to increased flows.	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.	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/permit 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 2 cm and 30 cm (>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 large 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 Isaf 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 permit 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).

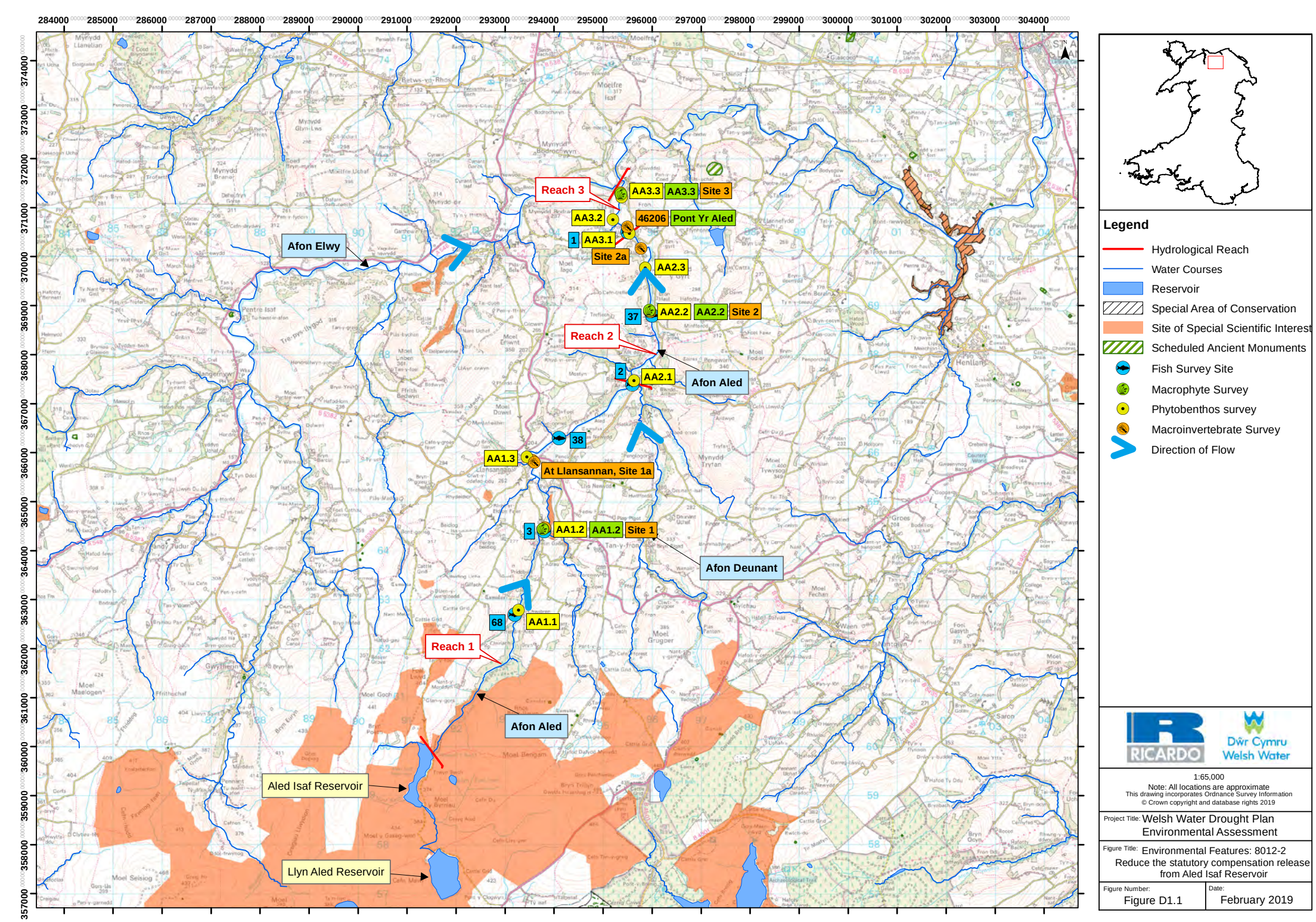
The assessment of environmental features is informed by the assessment of the physical environment (which includes hydrology and hydrodynamics; geomorphology; and water quality), this is summarised in Section 4 presented in full in **Appendix B**.

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 river reaches for the Aled Isaf 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:

[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.


Reach 3
AA3.3
AA3.3
Site 3
AA3.2
46206
Pont Yr Aled
1
AA3.1
Site 2a
AA2.3
Afon Elwy
37
AA2.2
AA2.2
Site 2
Reach 2
2
AA2.1
Afon Aled
38
AA1.3
At Llansannan, Site 1a
3
AA1.2
AA1.2
Site 1
Afon Deunant
68
AA1.1
Reach 1
Afon Aled
Aled Isaf Reservoir
Llyn Aled Reservoir
Legend
Hydrological Reach
Water Courses
Reservoir
Special Area of Conservation
Site of Special Scientific Interest
Scheduled Ancient Monuments
Fish Survey Site
Macrophyte Survey
Phytobenthos survey
Macroinvertebrate Survey
Direction of Flow
RICARDO
Dŵr Cymru Welsh Water
1:65,000
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: 8012-2 Reduce the statutory compensation release from Aled Isaf Reservoir
Figure Number: Figure D1.1
Date: February 2019

D2 DESIGNATED SITES

D.2.1 Coed Llys-Aled SSSI

D.2.1.1 Baseline

Designated due to high botanical importance. The woods represent one of the best examples in Clwyd of broadleaf woodland at medium altitudes and rainfall conditions. The woodland predominantly consists of sessile oak *Quercus petraea* with occasional rowan *Sorbus aucuparia*. The woodland close to the Afon Aled has a more varied tree canopy with sessile oak *Quercus petraea*, ash *Fraxinus excelsior*, in addition to wych elm *Ulmus glabra* and alder *Alnus glutinosa*.

D.2.1.2 Assessment

The Coed Llys Aled SSSI has been designated for its area of mixed deciduous woodland developed on the steep valley sides of the Afon Aled and Afon Hyrdd. The woods represent one of the best examples in Clwyd of a woodland-type occurring mainly in Scotland, Wales and Northern England at medium altitudes and under medium rainfall conditions. Upland oak woodland is considered to be highly water dependent however the habitat is typically dependent of rainfall and groundwater. .

Though the SSSI is adjacent to the Afon Aled the designated features of the site do not rely on specific water levels in the river and there is no hydrological connectivity between the waterbodies and the surrounding SSSI. It can therefore be concluded that implementation of a drought permit would impact the designated features of the SSSI ; ; impacts to the designated features of the SSSI are assessed as **negligible**.

D.2.2 Coed Nant-y-Merddyn-Uchaf SSSI

D.2.2.1 Baseline

The site is of interest for the semi-natural broadleaf woodland with a high proportion of sessile oak *Quercus petrea*. The woodland is dominated by a variety of broadleaved trees and shrubs including sessile oak *Quercus petrea*, downy birch *Betula pubescens*, ash *Fraxinus excelsior*, wych elm *Ulmus glabra* and hazel *Coryllus avellana*.

D.2.2.2 Assessment

The Coed Nant-Y-Merddyn-Ucaf SSSI has been designated for its area of mixed deciduous woodland developed on the steep valley sides of the Afon Aled representing the best example in Clwyd of a woodland-type occurring mainly in Scotland, Wales and Northern England at medium altitudes and under medium rainfall conditions. The majority of the designated features are related to the woodland nature of the site and these features do not rely on specific water levels in the river in order to achieve favourable condition.

The SSSI citation does note that the streamsides support an interesting flora including

uncommon species, however, as the proposed drought permit is only likely to result in a 14% drop in water levels this is not considered sufficient to adversely impact on these species in such a way that they would not be able to recover when the flows increased.

Upland oak woodland is considered to be highly water dependent however the habitat is typically dependent of rainfall and groundwater. However the woodland habitat present in the Coed Nant-y-Merddyn-Uchaf SSSI is not dependent on the Afon Aled and therefore not susceptible to impacts arising from the implementation of the Llyn Aled drought permit; impacts to the designated features of the SSSI are assessed as **negligible**

D.2.3 Mnydd Hiraethog SSSI

D.2.3.1 Baseline

Mnydd Hiraethog SSSI is one of the four remaining extensive tracts of sub-montane heather, *Calluna vulgaris* heath in the former county of Clwyd. The site is of interest for a number of key features:

- Dry Heath
- Blanket Bog
- Mixture of other associated heath and mire habitats
- Upland Breeding Bird assemblage
- Assemblage of Nationally Rare and Scarce bryophytes
- Assemblage of Nationally Rare and Scarce invertebrates

D.2.3.2 Assessment

The Mynydd Hiraethog SSSI has been designated for a number of habitats and species including: sub-montane heather heath, acidic blanket bog, natural oligotrophic lakes and a diverse upland bird assemblage. Of these the only feature that could be impacted by the drought permit is natural oligotrophic lakes. However, both reservoirs are outside the SSSI designation (though they border it) and there is no hydrological connectivity between the waterbodies and the surrounding SSSI (i.e. the water level in the reservoir has no impact on the adjacent habitats) so they have been screened out of further assessment.

Though there are several bird species that could utilise open water (black-headed gull Chroicocephalus ridibundus) or the reservoir margins (curlew Numenius arquata, snipe Gallinago gallinago, dunlin Calidris alpina, common sandpiper Actitis hypoleucos) none of these species rely on specific water levels for any life cycle stage and so a minor fluctuation would have no impact.

The SSSI contains a number of rare bryophyte species including the slender green feather

moss *Hamatocaulis vernicosus*. Slender green feather moss is designated under the Wildlife and Countryside Act 1981 (Schedule 8) and Habitats Directive Annex 2 - non-priority species. The notable bryophytes at the site are typically associated with base rich wet flushes and fens so are susceptible to changes in water level but are not dependent on the Afon Aled or reservoirs. Impacts to the designated features of the SSSI are therefore assessed as **negligible**.

Summary

The potential impacts of the Aled Isaf drought permit on designated sites are summarised in **Table D2.1**. The impacts, and their magnitude, have been based on the hydrological impacts (see **Appendix B** and 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 designated sites.

Table D2.1 Summary of Impacts on SSSI Designated Sites and Species

Feature	Impact	Significance of Impact
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Coed Llys-Aled SSSI	• The features for which the site is designated are not dependant on the Afon Aled.	**Negligible**
Coed Nant-y-Merddyn-Uchaf SSSI	• The features for which the site is designated are not dependant on the Afon Aled.	**Negligible**
Mynydd Hiraethog SSSI	• No water dependant features are located within the zone of hydrological influence	**Negligible**

D3 WFD STATUS AND COMMUNITY ASSESSMENT / NOTABLE SPECIES

D.3.1 Macrophytes

D.3.1.1 Baseline

No baseline macrophyte monitoring information was received from Natural Resources Wales (NRW) for Reach 1 in the Aled - above Deunant (GB110066054930) water body. Reaches 2 and 3 are located in the WFD Cycle 2 waterbody GB110066059770 (Aled - Elwy to Deunant). No recent baseline macrophyte data was provided for this waterbody, however data are available for a survey in 2002 by NRW for the site Pont Yr Aled, which is located in Reach 3, approximately 500m downstream of the Bryn Aled abstraction. Whilst no data is available for impacted Reaches 1 and 2, the macrophyte communities present are assumed to be similar to the community identified at the Pont Yr Aled and typical in upland rivers of this type.

Welsh Water commissioned APEM to undertake macrophyte monitoring in Reaches 1-3 (one location per reach)[4]. The sampling was completed in summer 2017. A total of three surveys were completed following UKTAG recommendations that all macrophyte samples are taken in the period June to September, inclusive.

[4] Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

Welsh Water also commissioned Ricardo Energy & Environment to undertake macrophyte monitoring in Reaches 1-3 (one location per reach)[5]. Sampling was completed in summer 2018 with a total of three surveys undertaken.

Considering the temporal constraints on the baseline information, which are not considered to be sufficient to characterise the whole watercourse, care must be taken in their interpretation. In particular, the age of some the data is of concern. In addition to the possible changes to environmental conditions and therefore macrophyte communities over time, the changes in macrophyte survey methods for the development of the LEAFPACS classification system (i.e. expanded recorded taxa list, particularly in relation to riverine bryophytes) in the intervening period mean that the data available may not represent as complete a record of the macrophyte community as would be gathered by current macrophyte monitoring protocols.

The description and assessment provided below is based on the assumption that the data available provides a relatively reliable representation of the likely communities present within the impacted reaches. .

Macrophyte analysis results were provided by NRW, APEM and Ricardo Energy & Environment, using the standard LEAFPACS2 methodology[6] in accordance with the requirements of the Water Framework Directive (WFD). This methodology is based on the principle that different combinations, quantities, and numbers of macrophytes are associated with different flow conditions and nutrient availability in a river. The LEAFPACS2 method assesses the condition of river macrophyte communities using data on presence and abundance of species and groups of species recorded during a standard survey comprising a 100m river section. These indices are briefly described below:

(i) River Macrophyte Nutrient Index (RNMI): an index of eutrophication (high scores indicate enriched conditions);

(ii) Number of macrophyte taxa which are truly aquatic, i.e. hydrophytes (NTAXA);

(iii) Number of functional groups of macrophyte taxa which are hydrophytes (NFG): an assessment of the structural diversity of the plant community; and

Table D3.1 Macrophyte Biotic Indices Scores within the Hydrological Zone of Influence

Site	Reach	Grid Reference	Year	RMNI	NTAXA	NFG
Pont Yr Aled	3	SH9550070600	2002	5.19	11	5.11
AA1.2	1	SH9377764443	2017	4.52	6	3.0
AA2.2	2	SH9593768931	2017	5.10	12	7.0
AA3.3	3	SH9536671387	2017	5.52	11	7.0

[5] Ricardo (2018) Aled & Aled Isaf Drought Plan Environmental Monitoring Report, November 2018.
[6] WFD-UKTAG (2014) UKTAG river assessment method – macrophytes and phytobenthos (River LEAFPACS2).

AA1.2	1	SH9377164440	2018	4.78	10	4.0
AA2.2	2	SH9594768909	2018	5.15	16	9.0
AA3.3	3	SH9536571281	2018	5.28	11	6

On average a total of 11 macrophytes were recorded across all sites within the impacted reaches (**Table D3.1**). The RMNI scores derived from this data describes macrophyte communities of moderate nutrient levels. The macrophyte communities are dominated by bryophytes including the presence of a number of nutrient tolerant species such as *Fontinalis antipyretica* and *Platyhypnidium riparioides* which were recorded with cover values of 5-10% and 10%-25% respectively. Total cover of algae is an indication of acute nutrient releases, with high cover values coinciding with sudden increases in nutrient levels. In these surveys the algal community consists of *Lemanea fluviatilis*, and *Cladophora aegagropila* two species considered a normal part of the flora in oligo-mesotrophic upland streams and rivers, and not typical of algal blooms associated with high nutrient levels. These communities do not provide any evidence for acute nutrient increases at time of the surveys.

D.3.1.2 Assessment

The implementation of this drought permit will result in minor beneficial hydrological impacts to the Llyn Aled and Aled Isaf reservoirs. In the context of environmental drought this will also benefit the macrophyte community by reducing the adverse environmental conditions of a drought. As such no further assessment of the macrophyte community in the Llyn Aled or Aled Isaf reservoirs is required.

The assessment of impacts on the macrophyte community should be considered in the context of the watercourse under a baseline of drought conditions. Baseline data indicates that the macrophyte community in the hydrological zone of influence of the drought permit is bryophyte dominated and is likely to be adapted to moderate flow velocities (RMHI and MFR scores were not available). Reduction in flows could affect macrophyte communities in a number of ways:

- Reduction in velocity favouring species adapted to slower flow conditions
- Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes
- desiccation of submerged macrophyte beds due to reduced wetted width and water depth
- reduction in flow rate leading to reduction or movement of the splash zone from where this usually occurs, both at the edges of the channel and around in-stream features such as boulders and exposed bedrock, leading to desiccation of species present within these areas, particularly bryophytes.

- shading of macrophyte stands by epiphytic algae, due to decreases in velocity, increases in water temperature, and potential increases in SRP concentrations;
- change in community composition due to increased SRP concentration altering growth rate and occurrence of filamentous algae.

Due to the potential change to wetted area, velocities, splash, and humidity, which could occur at any time of year, including the main macrophyte growing season, operation of the drought permit has the potential to affect the condition, composition and extent of macrophyte communities. The water quality assessment has identified a low risk of increased SRP in Reach 1 and a medium risk in Reaches 2 and 3. The low flows combined with increased in SRP concentration will favour the proliferation of filamentous algae, epithetic algae, opportunistic macrophyte taxa, which would result in changes to community composition and structure.

Hydrological impacts as a result of drought permit implementation range from major to minor in Reaches 1-3 depending on time of year and distance from the reservoir. See **Appendix B** for further details. These hydrological impacts associated with a reduction in compensation discharge will include a reduction in wetted width and wetted depth below those normally observed in the Afon Aled.

For Reach 1, (Aled Isaf Reservoir Outflow to Afon Deunant confluence) operation of the drought permit will results in minor hydrological impacts from September to January. The effects of the drought permit on the macrophyte community would be limited to the end of the main growing season. Therefore, considering the limited sensitivity of the communities present within the reach and the magnitude of hydrological and water quality impacts, the impact of the drought permit on macrophytes communities in Reach 1 is expected to be **negligible.**.

Hydrological impacts on Reach 2 (Afon Deunant confluence to Bryn Aled intake) are expected to be minor to negligible during the September to January period.. The effects of the drought permit on macrophyte communities are expected to be similar to those discussed for Reach 1.. Impacts of the drought permit on the macrophyte community in Reach 2 are therefore expected to be **negligible**.

Hydrological impacts on Reach 3 (Bryn Aled intake to Afon Elwy confluence) are expected to be moderate to minor (reductions of 15% and 19% in Q_{95} and Q_{99} Given the community composition, reduction in flow, and medium risk of increased SRP concentrations, impacts on the macrophyte community in Reach 3 are expected to be **minor**

Summary

The potential impacts of the Aled Isaf drought permit on the macrophyte community are summarised in **Table D3.2**. 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 D3.2** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.2 Summary of Impacts on Macrophyte Community

Feature	Impact	Significance of Impact
Reach 1 – Aled Isaf Reservoir outflow9 to Afon Deunant confluence		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Negligible**
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Negligible**
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Macrophytes	• Reduction in growth as a result of moderate - minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width / depth. • Alteration of splash zone reducing habitat suitability for bryophytes	**Minor**

Due to the impact described above implementation of the Aled Isaf drought permit will result in a **negligible** risk of short-term deterioration in status of the macrophyte and phytobenthos component Aled - above Deunant (GB110066054930) waterbody. The Aled - Elwy to Deunant (GB110066059770) waterbody will be at **minor** risk of short term deterioration

D.3.2 Macroinvertebrates

D.3.2.1 Baseline

No recent baseline macroinvertebrate monitoring information (within the last 10 years) was received from Natural Resources Wales (NRW) for Reach 1 in the Aled - above Deunant (GB110066054930) water body. Reaches 2 and 3 are located in the WFD waterbody GB110066059770 (Aled - Elwy to Deunant). Baseline macroinvertebrate data has been provided for this waterbody by NRW which consists of macroinvertebrate data collected from one site, Pont Yr Aled (Site number: 46206), which is located approximately 500m downstream of the Aled Isaf abstraction. Whilst no data is available for Reaches 1 and 2 it is assumed to be similar to the community identified at the Pont Yr Aled sampling site.

Welsh Water commissioned APEM to undertake macroinvertebrate sampling in reaches 1-3 (two sites per reach)[7]. The sampling was completed in spring, summer and autumn (three

[7] Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

occasions) of 2017. A total of 18 samples were collected across the three reaches and the three seasons.

Welsh Water commissioned Ricardo Energy & Environment to undertake macroinvertebrate sampling in reaches 1-3 (two sites per reach) [8]. Sampling was completed in summer 2018 and a total of five out of six samples were collected across the three reaches. The sixth sample was unobtainable within reach 3 due to access constraints at the time of sampling. Sampling was conducted by following the standard NRW protocol involving a three minute kick / sweep sample encompassing all the available instream habitats in proportion to their occurrence. For data collected prior to 2012 macroinvertebrates were identified to family level, from 2012 onwards macroinvertebrate were identified to species or mixed taxon level. These datasets were used to calculate a series of standard biotic indices: Biological Monitoring Working Party (BMWP) scores; Average Score Per Taxon (ASPT) scores; Lotic Invertebrate Flow Evaluation (LIFE); and number of taxa (NTAXA).

LIFE scores are used to assess how sensitive a macroinvertebrate community is to change in flow. Family LIFE scores are provided for all available data. See **Table D3.3** for interpretation of scores.

BMWP is primarily used to monitor the impact of organic water quality but also responds to other pressures such as habitat reduction, siltation and toxic pollutants. High BMWPs are associated with good water and habitat quality. Comparisons between sites with BMWP scores must be used with caution as change to river type can have considerable influence over BMWP score. ASPT is derived from BMWP and provides the average BMWP sensitivity score of all the taxa found in the sample's macroinvertebrate assemblage. This index provides a more reliable means of comparing macroinvertebrate community quality between sites whilst also reducing the influence of sampling artefacts such as variable sampling effort. As such ASPT is used as the primary means of assessing macroinvertebrate response to water quality in this assessment. As a guide ASPT scores above 5 represent macroinvertebrate communities living in good water quality. Scores below 5 indicate water quality stress on the macroinvertebrate community.

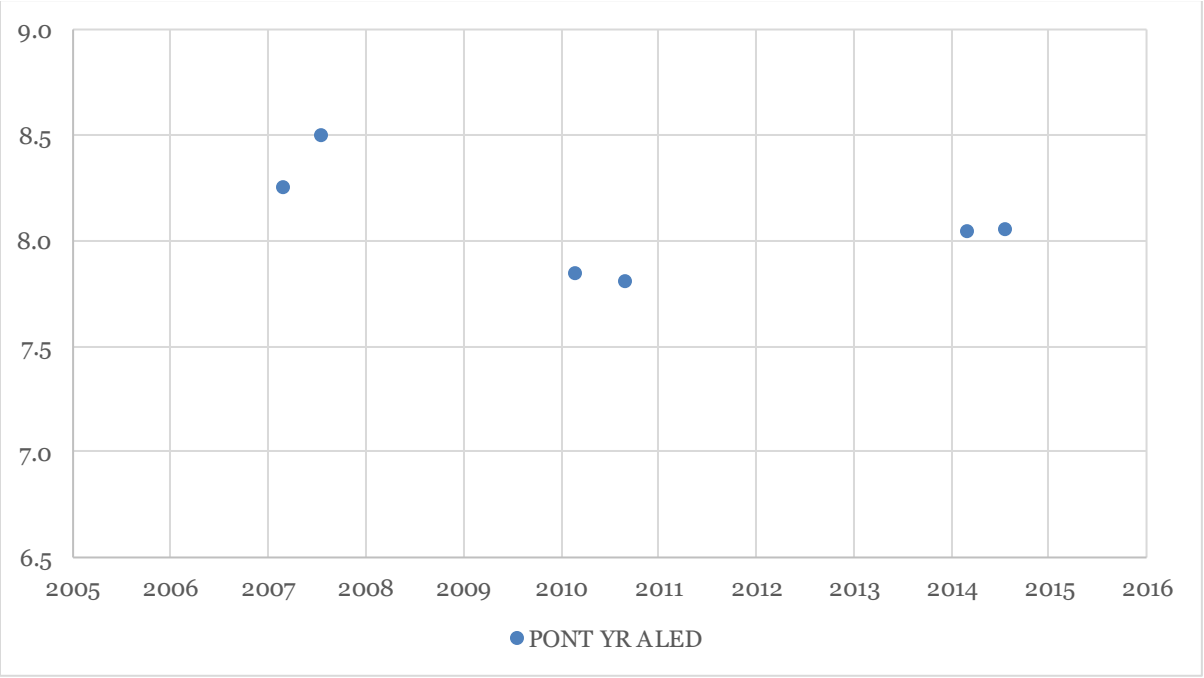
[8] Ricardo (2018) Aled & Aled Isaf Drought Plan Environmental Monitoring Report, November 2018.

Table D3.3: Interpretation of Macroinvertebrate Community LIFE Scores

LIFE score	Invertebrate community flow sensitivity
7.26 and above	High sensitivity to reduced flows
6.51 – 7.25	Moderately sensitive to reduced flows
6.5 and below	Low sensitivity to reduce flows

LIFE scores obtained from the site Pont Yr Aled are displayed in **Figure D3.1**. The scores range from 7.8 to 8.5 across the monitoring period. This describes a macroinvertebrate community which is highly sensitive to reduced flows and therefore is consistent with that found in fast flowing water.

Figure D3.1: Observed Family LIFE scores within Reach 3 of the Afon Aled



BMWP is primarily used to monitor the impact of organic water quality but also responds to other pressures such as habitat reduction, siltation and toxic pollutants. High BMWPs are associated with good water and habitat quality. Comparisons between sites with BMWP scores must be used with caution as change to river type can have considerable influence over BMWP score. ASPT is derived from BMWP and provides the average BMWP sensitivity score of all the taxa found in the sample's macroinvertebrate assemblage. This index provides a more reliable means of comparing macroinvertebrate community quality between sites whilst also reducing the influence of sampling artefacts such as variable sampling effort. As such ASPT is

used as the primary means of assessing macroinvertebrate response to water quality in this assessment. As a guide ASPT scores above 5 represent macroinvertebrate communities living in good water quality, scores above 6 are indicative of rivers of exceptionally good quality. Scores below 5 indicate water quality stress on the macroinvertebrate community.

ASPT and BMWP scores from the site Pont Yr Aled are displayed in **Figure D3.2** and **Figure D3.3**. The ASPT score obtained from Pont Yr Aled range from 5.77 to 7.04 across the monitoring period. This reflects a macroinvertebrate community which is consistent with that found in good to high water quality. In this upland water body with no apparent water quality pressures influencing the water course this community meets expectation. This community is exemplified by the presence of a number of highly pollution sensitive species including a stonefly *Chloroperla torrentium*, Silver Sedge *Odontocerum albicorne,* and in 2014 the Blue-winged Olive *Serratella ignita.*

Figure 3.2: Observed ASPT scores from Reach 3 of the Afon Aled

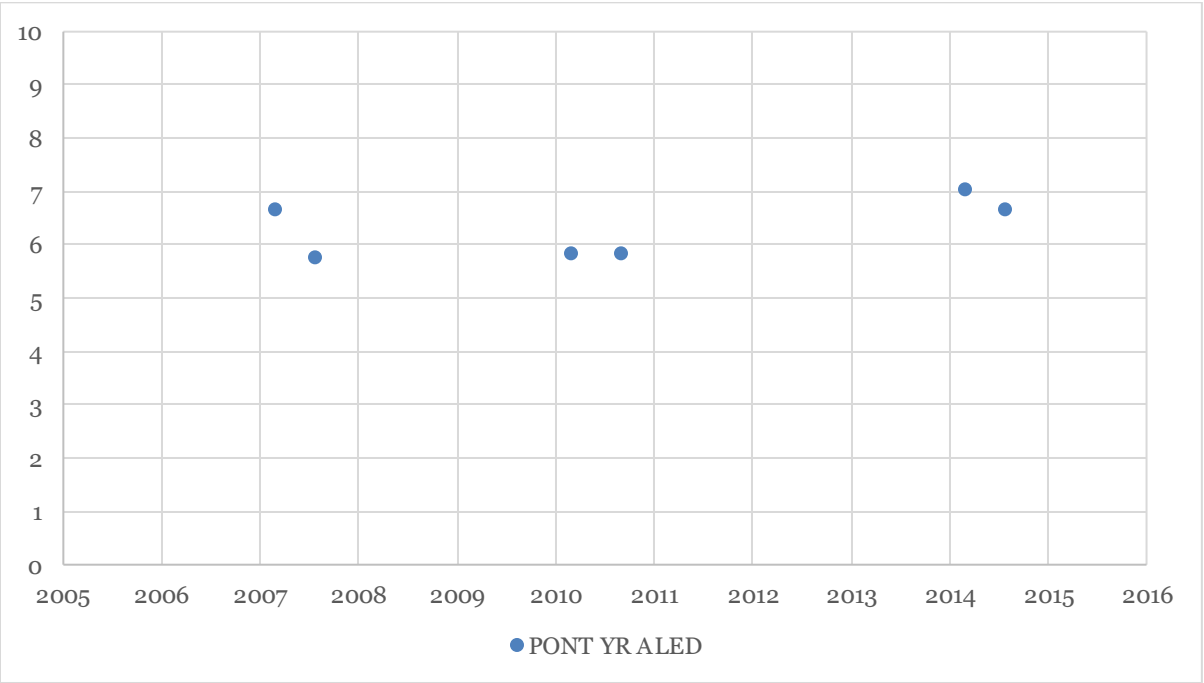
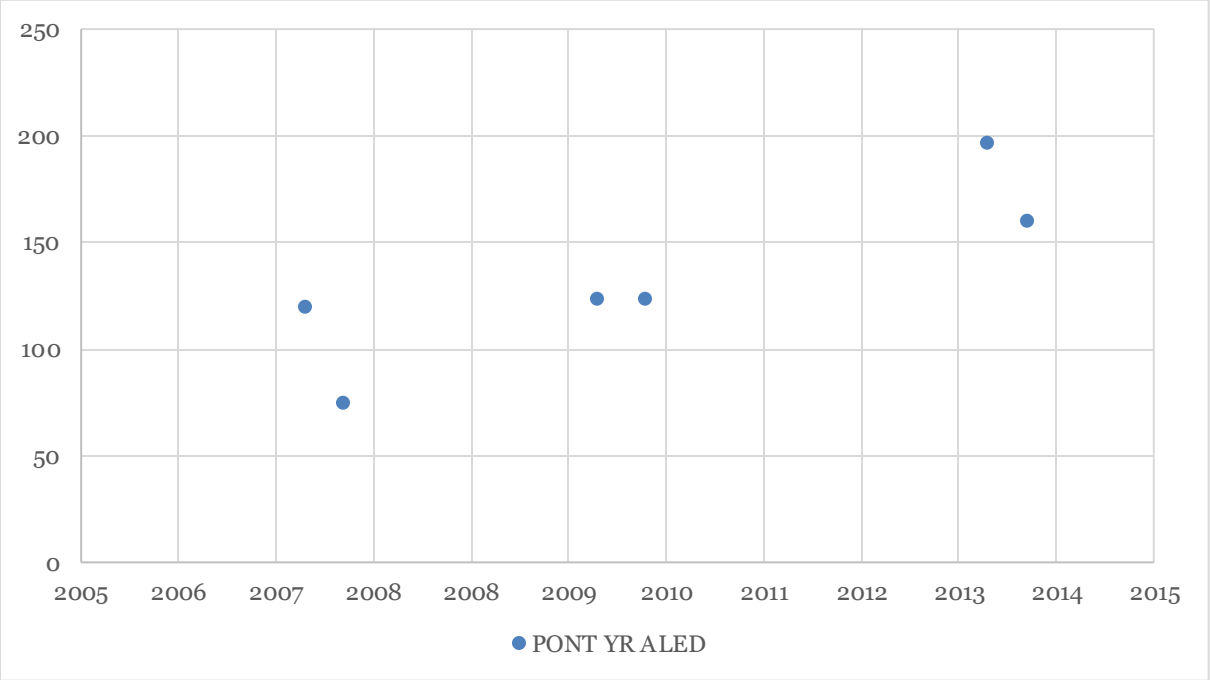


Figure 3.3: Observed BMWP scores from Reach 3 of the Afon Aled



Macroinvertebrate data collected by APEM yielded very similar results to NRW's historical monitoring (see Figure 3.3 to Figure 3.5). Macroinvertebrate assemblages were typical of relatively fast-flowing, unpolluted, gravel-bottomed streams. Family LIFE scores ranged from 7.61 to 8.32 across the monitoring period, which is indicative of a community that is highly sensitive to reduced flows and is therefore consistent with what is expected in faster flowing water. ASPT scores ranged from 5.80 to 6.88 and BMWP ranged from 116 to 196, across the monitoring period. These scores reflect a community which is consistent with that found in good to high water quality.

Data collected by Ricardo Energy & Environments sampling also yielded results that concur with both NRW's and APEM's sampling (see **Figure 3.4** to **Figure 3.6**). Family LIFE scores ranged from 7.50 to 8.06, which is indicative of a community that is highly sensitive to reduced flows and therefore consistent with what is expected in faster flowing water. ASPT scores ranged from 6.11 to 6.65 and BMWP scores ranged from 102 to 133 across the sampling period. These scores reflect a community which is consistent with that found in good to high water quality.

Figure 3.4: Observed LIFE scores from Reach 1 - 3 of the Afon Aled

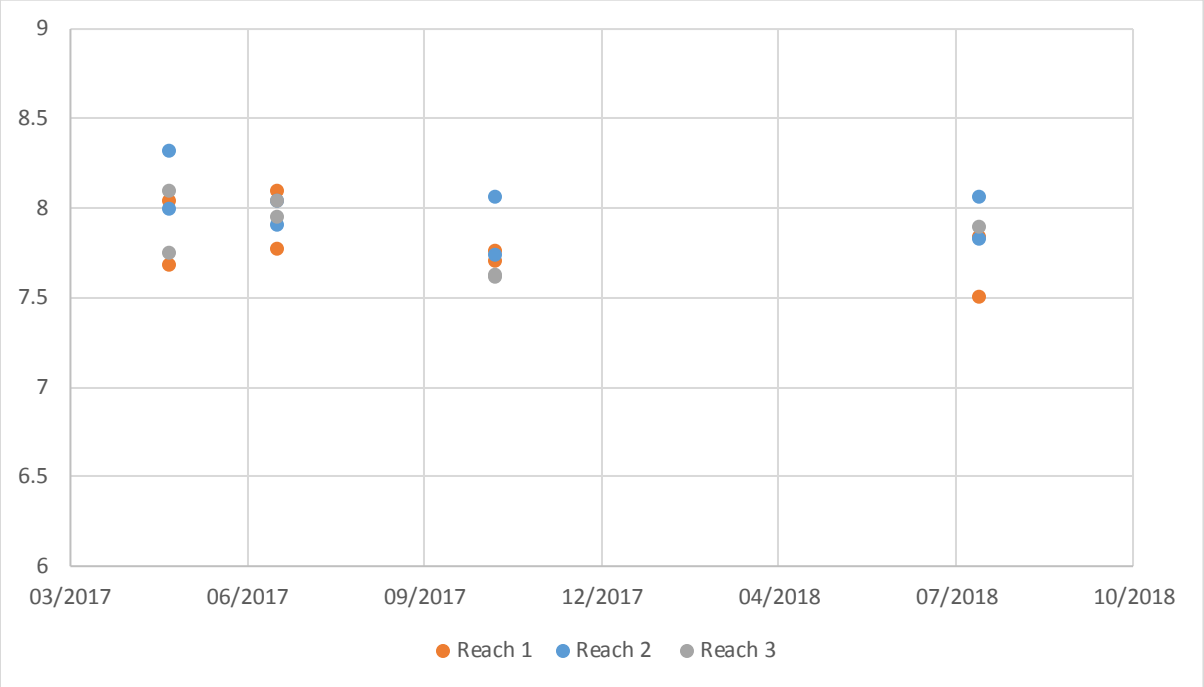


Figure 3.5: Observed ASPT scores from Reach 1 - 3 of the Afon Aled

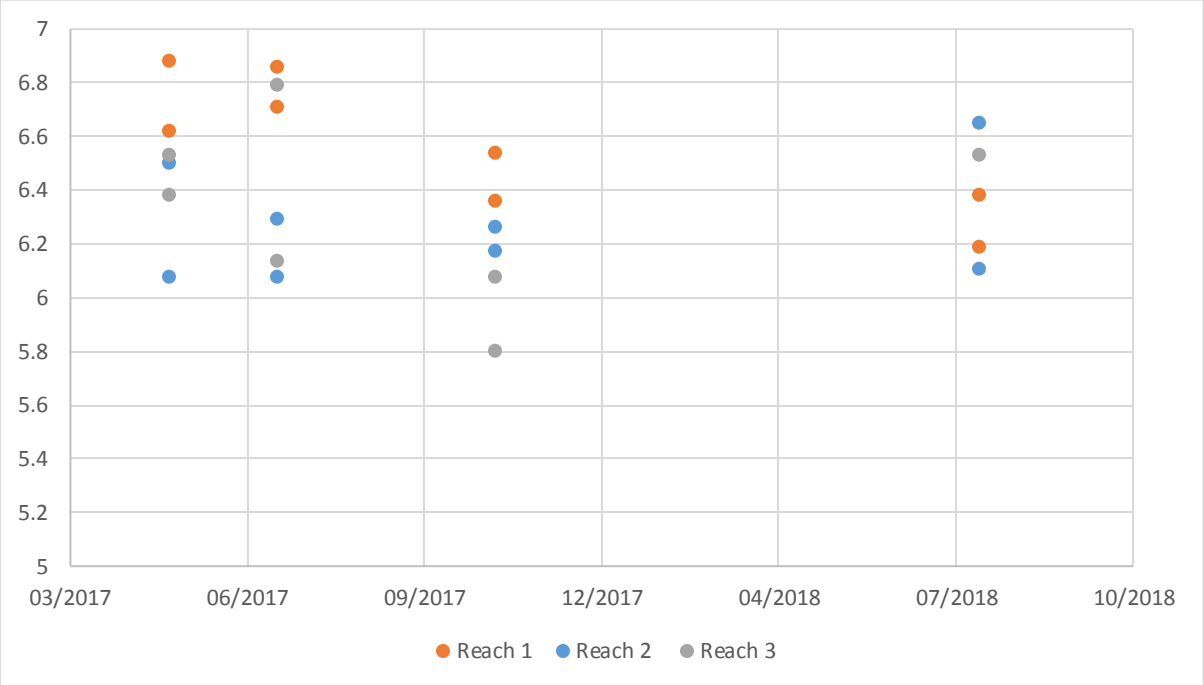
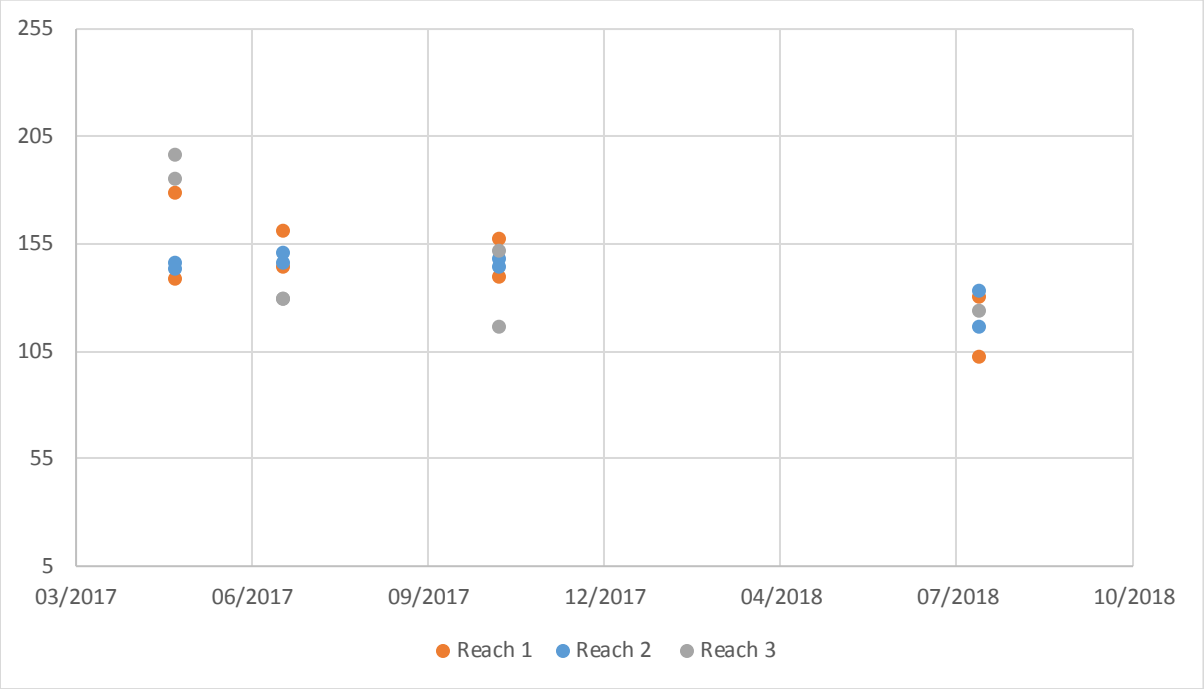


Figure 3.6: Observed BMWP scores from Reach 1 - 3 of the Afon Aled



Notable species

No records of white clawed crayfish *Austrapotambius pallipes* were present in the data included 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 *Margaritifera margaritifera* has previously been confirmed (Adrian Fowles, CCW, pers. comm.)[9], therefore, it is not considered further in this assessment.

Macroinvertebrate monitoring undertaken by APEM and Ricardo Energy & Environment recorded one diving beetle species of Notable status found in each season of sampling (spring, summer and autumn).

D.3.2.2 Assessment

The implementation of this drought permit will result in minor beneficial hydrological impacts to the Llyn Aled reservoir and no impacts to the Aled Isaf reservoir. In the context of environmental drought this will benefit the macroinvertebrate community by reducing the adverse environmental conditions of a drought. As such no further assessment of the macroinvertebrate community in the Llyn Aled reservoir and Aled Isaf reservoir is required.

Baseline data collected for Welsh Water describes a macroinvertebrate community in the

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

impacted reaches which is highly sensitive to reduced flows, with a high proportion of species preferring fast flowing waters. It is likely that in the short-term this impact will modify the macroinvertebrate community with a loss of species which prefer fast flows and proliferation of invertebrates which favour slower flows. This will likely be reflected by a reduction in LIFE scores and number of taxa present. Lifecycle may also be impacted as effects of this drought permit will occur in the autumn and winter period (September to January). During this time changes to flow may influence macroinvertebrate species with a spring emergence, as the majority of these species lay their eggs in autumn with the eggs overwintering in the watercourse and therefore recruitment may be reduced. Reduction in wetted width or depth may result in desiccation of temporary habitats and depending on the rate of flow reduction may cause stranding of invertebrates in marginal habitats.

There is considered to be low risk to changes in dissolved oxygen and ammonia concentrations in Reaches 1 – 3 (See **Appendix B** Section B.3.2 Water Quality assessment) as a result of implementation of the drought permit. Therefore, there is a risk of changes to community composition with a reduction in distribution or abundance of sensitive taxa and proliferation of more tolerant taxa. The macroinvertebrate communities present contain a high proportion of ephemeroptera, trichoptera, and plecoptera families which are particularly sensitive to reductions in dissolved oxygen concentrations. In addition the low risk of increased ammonia concentration may lead to changes in community composition with the loss or reduction in abundance or distribution of sensitive taxa (such as freshwater shrimp gammaridae).

Typically, invertebrate communities can recover rapidly from short term flow and water quality impacts as a result of immigration from upstream habitats. In the context of Reach 1, recovery of the invertebrates will be negatively affected by the lack of upstream communities. However, invertebrate recovery will also involve aerial recolonization and refugium-use strategies. As such invertebrate recovery following the cessation of the drought permit and return to standard flow will likely be rapid.

Impacts of the drought permit in all reaches are expected to be **minor**, adverse, temporary, and short term.

Summary

The potential impacts of the Aled Isaf drought permit on the macroinvertebrate community are summarised in **Table D3.4**. 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 macroinvertebrate community. The impacts presented in **Table D3.4** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.4 Summary of Impacts on Macroinvertebrate Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and / or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width. • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and / or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Macroinvertebrates	• Change in community composition due to reduction in species diversity and / or abundance as a result of the loss of flow-sensitive taxa. • Reduction in abundance or distribution of sensitive species due to changes in water quality. • Loss of marginal habitats from reductions in depth / width • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**

There is a minor risk of short-term deterioration in status of the macroinvertebrate component of the waterbody Aled - above Deunant (GB110066054930). In addition, there is a minor risk of short term deterioration of the macroinvertebrate component of the Elwy to Deunant (GB110066059770) waterbody.

D.3.3 Fish

Existing Data

NRW fish survey data from six sites encompassing Reaches 1-3 have been analysed as part of this assessment (see **Table D3.5**). The sites have not been sampled consistently either across years or in terms of methodology, however, recent data (post 2015) is available for all reaches of the hydrological zone of influence and the geographical coverage of the monitoring locations gives a useful insight into the likely species assemblage. In addition to the NRW data, Welsh Water commissioned APEM to undertake five quantitative surveys of the Afon Aled in 2017[10], consisting of two sites in Reach 1, three sites in Reach 2 and one site in Reach 3. Lamprey specific surveys were also carried out as part of the APEM surveys.

The data made available consists of density estimates for 0+ and >0+ Atlantic salmon *Salmo salar* and brown / sea trout *Salmo trutta* from quantitative and semi-quantitative electric fishing surveys. Observations of incidental catches of other fish species are available for some years, whilst lamprey specific survey data is available for 2017 only (APEM data).

[10] Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

Table D3.5: NRW Fish Survey Data within the Hydrological Zone of Influence

Hydrological Reach	NRW Site Ref	River	NGR	Sampling Method and Years (Q = Quantitative, SQ = Semi-quantitative)
1	3	Afon Aled	SH93806440	SQ: 2003, 2009 & 2015
	38	Afon Aled	SH94106630	SQ: 2003, 2009, 2015 & 2018
	68	Afon Aled	SH93206270	SQ: 1997, 2018
2	2	Afon Aled	SH95606740	SQ: 1997, 2003 and 2009
	37	Afon Aled	SH96006880	SQ: 2003, 2009 and 2015
3	1	Afon Aled	SH9553970484	Q: 2001-2005 SQ: 1997, 2001-2011, 2013, 2015, 2016 & 2018

The 'Aled - Elwy to Deunant' waterbody (GB110066059770) was assessed as being at high status for fish in 2015.

Species Composition

Nine fish species have been recorded within the potential zone of influence; Atlantic salmon and bullhead *Cottus gobio* (both Environment (Wales) Act Section 7 and Habitats Directive Annex II species), brown / sea trout (Environment (Wales) Act Section 7 species), European eel *Anguilla anguilla* (Environment (Wales) Act Section 7 species and IUCN Red List 'Critically Endangered'), sea lamprey *Petromyzon marinus* (Environment (Wales) Act Section 7 and Habitats Directive Annex II species), river/brook lamprey *Petromyzontidae* sp., minnow *Phoxinus phoxinus*, stone loach *Barbatula barbatula* and stickleback *Gasterosteiformes* sp., river / brook lamprey ammocoetes of the *Petromyzontidae* family are indistinguishable in the field[11], and have therefore not been identified to species level.

Atlantic Salmon

The available data suggest that juvenile salmon are present throughout Reaches 1 - 3 and the long-term dataset for Site 1 in Reach 3 suggests considerable natural variation in juvenile salmon densities. Combined NFC grades[12] for fry and parr densities at this site ranged from A (excellent) to F (fishless) over the period 1997 to 2018 (see **Table D3.6**). APEM surveys in 2017 recorded both fry and parr in Reach 3 only, however the 2018 NRW surveys recorded juvenile salmon in Reach 1 and 3, indicating recruitment continues throughout much of the hydrological zone of influence.

Table D3.6 Juvenile Atlantic Salmon NFC Grades (Fry 0+ and Parr 1+ Combined) for NRW sites in Reaches 1 - 3

[11] Harvey J & Cowx I (2003). Monitoring the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*. Conserving Natura 2000 Rivers Monitoring Series No.5, English Nature, Peterborough.
[12] For salmonids, a grading system is used based on the original Fisheries Classification System called the National Fisheries Classification (NFC). The electric fishing data are analysed to produce a juvenile salmon and trout density score for each site, using average values from the early 1990s as a baseline. The proportion of sites falling into different salmon abundance Classes (A to F) provides a measure of the health of the juvenile salmon populations for each river. Sites are typically grouped into those that are at or above average (Classes A to C), below average (Class D) and well below average or fishless (Classes E or F).

Sample year	Combined 0+ and 1+ NFC Grade					
	Reach 1			Reach 2		Reach 3
	NRW Site 3	NRW Site 38	NRW Site 68	NRW Site 2	NRW Site 37	NRW Site 1
1997	D	-	-	D	-	D
2001	-	-	-	-	-	D
2002	-	-	-	-	-	C
2003	C	A	-	C	C	D
2004	-	-	-	-	-	C
2005	-	-	-	-	-	A
2006	-	-	-	-	-	B
2007	-	-	-	-	-	D
2008	-	-	-	-	-	C
2009	D	C	-	C	B	A
2010	-	-	-	-	-	B
2011	-	-	-	-	-	C
2013	-	-	-	-	-	A
2014	-	-	-	-	-	C
2015	E	D	-	-	D	D
2016	-	-	-	-	-	E
2018	-	D	F	-	-	C

Despite significant variation in juvenile Atlantic salmon densities across sites and years, the available data suggest that Reaches 1 – 3 provide important juvenile nursery habitat. Therefore, it must be assumed that the hydrological zone of influence also constitutes an essential migratory corridor for migrating adult and smolt-stage Atlantic salmon.

Bullhead

Density and individual length data were not made available for bullhead so a detailed account of the status of this species within the hydrological zone of influence is not possible, however, incidental catches during NRW salmonid surveys suggest that bullhead are present in Reaches 1 – 3, whilst APEM surveys in 2017 also recorded bullhead throughout the hydrological zone of influence.

Lamprey Species

Unidentified lamprey species have been recorded during NRW salmonid surveys at Sites 1 and 3 (Reaches 1 and 3), whilst APEM surveys recorded river/brook lamprey in Reach 1, 2 and 3. A suspected record of a sea lamprey (post-juvenile life stage) was recorded in the lower reach of Reach 1. A precautionary approach is used in the following assessment assuming that brook, river and sea lamprey are present in throughout the hydrological zone of influence.

Brown / Sea trout

The available data suggest that juvenile brown/sea trout are present throughout Reaches 1 – 3. The long-term dataset for Site 1 in Reach 3 suggests relatively minor natural variation in fry and parr densities with NFC C and D Grades recorded in most years from 1997 to 2018. Reaches 1 to 3 recorded Excellent (Grade A) grades in 2015, whilst the most recent data from 2018 recorded Good (Grade B) to Excellent (Grade A) grades in Reach 1 (see **Table D3.7**).

Table D3.7 Juvenile Brown/Sea Trout NFC Grades (Fry 0+ and Parr 1+ Combined) for NRW Sites in Reaches 1 - 3

Sample year	Combined 0+ & 1+ NFC Grade					
	Reach 1			Reach 2		Reach 3
	NRW Site 3	NRW Site 38	NRW Site 68	NRW Site 2	NRW Site 37	NRW Site 1
1997	D	-	-	D	-	D
2001	-	-	-	-	-	D
2002	-	-	-	-	-	C
2003	D	C	-	C	D	D
2004	-	-	-	-	-	C
2005	-	-	-	-	-	C
2006	-	-	-	-	-	B
2007	-	-	-	-	-	D
2008	-	-	-	-	-	D
2009	B	A	-	B	C	C
2010	-	-	-	-	-	D
2011	-	-	-	-	-	C
2013	-	-	-	-	-	D
2014	-	-	-	-	-	C
2015	A	A	-	-	A	A
2016	-	-	-	-	-	E
2018	-	B	A	-	-	D

Anecdotal evidence from local angling clubs suggests sea trout migrate as far upstream as Reach 1[13]. A precautionary approach assumes that the anadromous life form of the species spawns alongside non-migratory brown trout throughout Reaches 1 – 3.

European eel

Density data were not made available for European eel, however, incidental catches during NRW salmonid surveys suggest that the species is present in low densities throughout Reaches 1 – 3. APEM survey data in 2017 recorded European eel in Reach 1 only, whilst NRW surveys in 2018 recorded the species in Reach 1 and 3, indicating the species remains reasonably distributed throughout the hydrological zone of influence. In terms of size ranges, the APEM surveys in 2017 recorded both elver (juvenile) and yellow (post juvenile) life stages of eel, indicating the species are able to migrate as far upstream as Reach 1.

[13] Wild Trout Wales & Environment Agency Wales (2007). Advisory Visit - 14th June 2007 - River Afon Aled – North Wales. On Behalf of Rhyl & St Asaph AA

Other Species

Density data were not made available for minor species (minnow, stone loach and stickleback), however, incidental catches during NRW salmonid surveys suggest that these species are present in low densities in Reach 1 (stone loach only) and Reach 3 (stickleback and minnow).

Data Limitations

There is some uncertainty surrounding the status of a number of the protected fish species present, including lamprey species and bullhead. The following assessment should therefore be interpreted with caution.

Ecological value of fisheries receptors

Atlantic salmon, sea and river lamprey, and bullhead are Environment (Wales) Act Section 7 and Habitats Directive Annex II species, and are considered to be of National importance. Brown/sea trout (Environment (Wales) Act Section 7 species) and European eel (Environment (Wales) Act Section 7 and IUCN Red List 'Critically Endangered' species) are also considered to be of National importance. Minnow, stone loach and stickleback are considered to be of Local importance only.

D.3.3.1 Assessment

Hydrological variability in rivers can have a significant influence on the distribution of fish. When sudden or extreme low flows, or prolonged periods of low flow, are experienced (for example under continued water abstraction during drought conditions), the resultant changes in the hydrological regime can have significant impacts on resident fish communities. Abstraction of water from a river or stream reduces the wetted area and volume with the potential for subsequent impacts on fish populations as a result of, for example, intra- and inter-specific interactions (e.g. increased competition for optimal habitat and food)[14,15], reduced water quality and reduced reproductive success, growth and condition[16].

Potential impacts relating to habitat loss, water quality and migration 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 year-round impact period. It should be noted that, whilst the Aled Isaf Drought Permit could be implemented at any point during the year, it would be most likely to occur during late summer and autumn (September to January). This option has limited hydrological impact in Reaches 1 and 2 but a more significant impact in during September in Reach 3, below the Bryn Aled intake. The hydrological impacts are associated with a reduction in low flows; there is no impact on medium or high flows.

Atlantic Salmon and Brown / Sea Trout

[14] 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
[15] 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.
[16] 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.

Atlantic Salmon and Sea Trout Migration

Atlantic salmon are known to be present in Reaches 1 – 3, whilst sea trout are also considered to be present as far upstream as Reach 1. Both species of migratory salmonids are considered to utilise spawning habitat throughout the hydrological zone of influence. The majority of Atlantic salmon migration into the Afon Aled is likely to occur from October to December with the bulk of sea trout migration occurring slightly earlier in the year and there is the potential for a drought permit to impact these migrations. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature, and this life stage is unlikely to be affected by a drought permit. Adult and smolt-stage Atlantic salmon and adult sea trout migration is linked to flow increases and river flow is considered to be a primary cue. If the Aled Isaf Drought Permit was applied during the summer/autumn (September to January), the reduction in river flow experienced downstream of the Bryn Aled intake may result in delayed adult migration. Delays in migration are associated with increased mortality due to increased predation and stress. However, this option only impacts low flows and, under these conditions associated with a natural drought, it is unlikely that salmonid migrations would occur.

The impact on adult salmonid migration is considered to be of medium magnitude in Reach 3 and low magnitude in Reaches 1 and 2, short-term, temporary and reversible. The impact on adult Atlantic salmon and sea trout migration (summer/autumn drought permit) is considered to be **moderate adverse** in Reach 3 and **minor adverse** in Reaches 1 and 2.

Water Quality

Atlantic salmon and brown/sea trout are susceptible to poor water quality and particularly dissolved oxygen and water temperature, however, water quality impacts have been assessed as low. The impact on Atlantic salmon and sea trout is therefore considered to be **minor adverse** in Reaches 1 – 3.

Atlantic Salmon and Brown/Sea Trout Spawning and Juvenile Habitat

There is the potential for reduced flows in Reaches 1 - 3 to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of gravel spawning and juvenile habitat. Provided minimum low flows are available, juvenile Atlantic salmon and brown/sea trout are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. If gravels containing redds and/or eggs (likely to occur from November to January) become de-watered, this is likely to have a more significant effect with the potential for significant mortality due to desiccation and increased predation. The impact is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on spawning and juvenile Atlantic salmon and brown/sea trout habitat is considered to be **moderate adverse** in Reach 3 and **minor adverse** in Reaches 1 and 2.

<u>Bullhead</u>

Bullhead are likely to be present throughout Reaches 1 - 3. Spawning and egg incubation takes place from March to May, with the most sensitive life stages unlikely to be impacted by drought permit. The species is also known to be flow sensitive and reduced flows are known to impact bullhead populations. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on bullhead is therefore considered to be **minor adverse** in Reaches 1-3.

Lamprey Species

Migration of river and sea lamprey

Mature river lamprey migrate upstream into freshwater in the autumn (from October to December[17]). River lamprey ammocoetes metamorphose after three to five years in freshwater and then descend to estuarine and marine environments between July and September in smaller rivers**Error! Bookmark not defined.**. Upstream migration requires a reasonable flow of water to aid passage past natural and non-natural in-channel barriers. Low flows may limit upstream passage and hinder downstream passage, leaving both migratory life stages exposed to predation and ultimately a reduction in recruitment. The impact is therefore considered to be of low/medium magnitude, short-term, temporary and reversible between September and January The impact on river lamprey migration is therefore considered to be **minor adverse** in Reaches 1 and 2 and **moderate adverse** in Reach 3.

Mature sea lamprey migrate upstream into freshwater in April and May prior to spawning. Sea lamprey ammocoetes metamorphose after approximately five years in freshwater and then descend to marine environments between July to September[18], with the greatest risks associated with the September to January period. The impact to the downstream migratory life stage of sea lamprey is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on downstream sea lamprey migration is therefore considered to be **minor adverse** in Reaches 1-3.

Juvenile (ammocoete and transformer) brook, river and sea lamprey habitat

Spawning and egg incubation is temperature dependant and tends to occur from March to July and are therefore unlikely to be affected be affected by this drought permit. There is the potential for reduced flow in Reach 3 in particular to result in a decrease in river levels and wetted width. This has particular significance for juvenile (ammocoetes and transformer) lamprey habitat which tends to consist of silt in shallow, marginal areas. There is the potential for a loss or degradation of this habitat. Provided minimum low flows are available, juvenile lamprey may relocate to areas of suitable habitat if river levels decrease, however, competition and stress would likely increase. The impact is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on juvenile lamprey habitat is therefore considered to be **moderate adverse** in Reach 3 and **minor adverse** in Reaches 1

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

and 2.

Water quality

Water quality impacts (e.g. reduced dissolved oxygen and increased water temperature) have been assessed as low and are not expected to have a significant impact on brook, river or sea lamprey which are not particularly sensitive to these effects. The impact on brook, river and sea lamprey is therefore considered to be **negligible** in Reaches 1 – 3.

European Eel

Elver enter rivers in early spring and a general upstream migration occurs throughout the summer and autumn. Elver migration is unlikely to be impacted by this Drought Permit. The downstream migration of mature (silver) eel tends to occur between September and December in most rivers and is linked to increased flow; there is therefore the potential for interaction with this drought permit. European eel of a wide age range are likely to be present in low densities throughout Reaches 1 - 3 but the species is relatively tolerant of low flows and poor water quality, and is considered resilient to reduced flow conditions. The impact on downstream silver eel migration is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on downstream silver eel migration is therefore considered to be **moderate adverse** in Reach 3 and **minor adverse** in Reaches 1 and 2.

Other Species

Minnow, stone loach and stickleback spawning and egg incubation occurs within the impact period for this drought permit (September to January). The rheophilic (require flowing water) minnow and stone loach are susceptible to impacts associated with pronounced changes in river flow, whilst stickleback are eurytopic (tolerant of lotic and lentic environments) and considered more robust to flow changes. Stickleback are therefore not considered to be negatively affected by the drought permit options. A reduction in low flows could result in increased mortality of minnow and stone loach due to higher densities of fish being subject to a greater risk of increased predation. The impacts are therefore considered to be of low magnitude, short-term, temporary and reversible (minnow and stone loach only). The impact on other fish species (minnow and stone loach only) is therefore considered to be **minor adverse** in Reaches 1-3.

Summary

The potential impacts of the Llyn Aled drought permit on the fish community are summarised in **Table D3.8**. 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 D3.8** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.8 Summary of Impacts on Fish Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Minor**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Minor** (River & sea lamprey)
	• Loss of juvenile habitat as a result of reduced river levels.	**Minor**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Minor**
Other species	• Increased mortality due to habitat loss.	**Minor**
Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Minor**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Minor** (River & sea lamprey)
	• Loss of juvenile habitat as a result of reduced river levels.	**Minor**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Minor**
Other species	• Increased mortality due to habitat loss.	**Minor**
Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	**Moderate**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Moderate**
Bullhead	• Increase in mortality due to habitat loss.	**Minor**
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	**Moderate** (River lamprey) **Minor** (sea lamprey)
	• Loss of juvenile habitat as a result of reduced river levels.	**Moderate**
	• Reduced water quality	**Negligible**
European eel	• Increased mortality due to habitat loss.	**Negligible**
	• Delays and potential cessation of downstream adult eel migration due to reduced flows.	**Moderate**
Other species	• Increased mortality due to habitat loss.	**Minor**

There is a risk of short-term deterioration in status of the fish components of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770), the waterbodies were classified as high for fish in Cycle 2, including the interim 2018 classification. Impacts of drought permit implementation on the fish communities of the

impacted reaches have been summarised as minor (Reaches 1-2) to moderate (Reach 3), short-term, temporary and reversible. Consequently, the fish component of Aled - Elwy to Deunant (GB110066059770) is considered to be at moderate risk of short-term deterioration.

D.3.4 Phytobenthos

D.3.4.1 Baseline

No baseline phytobenthos monitoring information was received from Natural Resources Wales (NRW) for Llyn Aled Reservoir. Considering the absence of baseline information care must be taken in interpretation of the assessment and should be seen as indicative only.

Welsh Water also commissioned Ricardo Energy & Environment to undertake phytobethos monitoring in reaches 1-3 (three location per reach) [19]. The sampling was completed in summer 2018. Surveys were undertaken using the DARLEQ2 methodology[20]. Based on the expected and observed phytobenthos community, the community is considered to be of good to high ecological status at all of the sampling sites (see **Table D3.9**). Taxa that were present in high abundances include common species such as *Achnanthidium minutissimum* type, *Cocconeis placentula* var. *euglypta*, *Cocconeis placentula* var. *pseudolineata* and *Gomphonema parvulum*.

Table D3.9 Phytobenthos DARLEQ2 parameters

Site	Reach	Grid Reference	Year	TDI4	EQR TDI4	Class TDI4
AA1.1	1	SH 9327462781	2018	34.9	1.0	High
AA1.2	1	SH 9377764443	2018	39.6	1.0	High
AA1.3	1	SH 9344965910	2018	41.7	0.9	High
AA2.1	2	SH 9563467462	2018	53.7	0.7	Good
AA2.2	2	SH 9594868898	2018	58.9	0.7	Good
AA2.3	2	SH 9586469772	2018	49.3	0.8	High
AA3.1	3	SH 9553770475	2018	52.9	0.8	Good
AA3.2	3	SH 9520570754	2018	54.2	0.7	Good
AA3.3	3	SH 9537771214	2018	55.5	0.7	Good

D.3.4.2 Assessment

Impacts on the phytobenthos assemblages of the Afon Aled within Reaches 1-3 could occur due to the operation of the drought permit, including changes in community composition due to: decreases in flow; changes to grazing pressure; increases in nutrient level; increases in water temperature; and increases in filamentous algae smothering the substrate. Due to the short lifecycle of algal species, phytobenthos communities can respond rapidly to environmental change and a response in phytobenthos community composition to the reduction in flows due to the drought permit would be expected.

[19] Ricardo (2018) Aled & Aled Isaf Drought Plan Environmental Monitoring Report, November 2018.

[20] UKTAG (2014) UKTAG River Assessment Method. Macrophytes and Phytobenthos; Phytobenthos (River DARLEQ2). July 2014

Implementation of the drought permit in Reach 1 is expected to result in low risk to water quality deterioration related to SRP concentration; in Reaches 2 and 3 a medium risk is expected. Any increase in SRP is likely to affect the phytobenthos community in terms of TDI score and associated WFD status.

Due to the rapid response of phytobenthos communities to environmental variables, this effect is expected to be short lived, with communities recovering rapidly following return to the normal hydrological regime.

The impacts of the drought permit on phytobenthos communities are therefore assessed as negligible for Reach 1 and minor for Reaches 2 and 3.All impacts are deemed short term and reversible.

Summary

The potential impacts of the Aled Isaf drought permit on the macrophyte community are summarised in **Table D3.10**. 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 D3.10** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.9 Summary of Impacts on Phytobenthos Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Aled		
Diatoms	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Negligible**
Reach 2 – Afon Aled		
Diatoms	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Minor**
Reach 3 – Afon Aled		
Diatoms	• Decrease in flow affecting phytobenthos community composition • Low risk of increase in SRP affecting phytobenthos community composition and TDI score	**Minor**

The phytobenthos sub-component of the Afon Aled - above Deunant (GB110066054930) waterbody is considered to be at **negligible** risk of short-term deterioration. The phytobenthos subcomponent the Aled - Elwy to Deunant (GB110066059770) waterbody of the is considered to be at **minor** risk of short term deterioration

D4 INVASIVE FLORA AND FAUNA

D.4.1 New Zealand Pigmyweed

D.4.1.1 Baseline

Anecdotal reports were received of New Zealand pigmyweed (*Crassula helmsii)* in NRW assets in the region. The species is known to be present in and around Llyn Brenig reservoir, located 5km east of Llyn Aled. The UK New Zealand pigmyweed occurs in a variety of habitats including ponds, lakes, canals, and ditches as well as on damp mud on the margins of ponds and reservoirs. The species can tolerate a wide range of environmental conditions, from basic to acidic and oligotrophic to eutrophic[21]. Where it occurs it can form dense mats shading out native vegetation and choking watercourses. Distribution occurs through vegetative means; full plants can grow from very small vegetative fragments.

Welsh Water commissioned Ricardo Energy & Environment (REE) to conduct a total of three surveys, which were undertaken between 30 July and 1 August 2018. The surveys included a visual inspection of the shore of Llyn Aled and Aled Isaf Reservoirs and at nine sites along the Afon Aled. In addition to the REE surveys, APEM conducted macrophyte surveys at Aled Isaf, paying special attention to the presence/absence of *Crassula helmsii*. No *Crassula helmsii* was found at any of the sites, on any of the Welsh Water commissioned surveys.

D.4.1.2 Assessment

Due to its preference for slow flowing water bodies New Zealand pigmyweed is likely to be absent from the impacted reaches of the Afon Aled and is not considered further for the impacted river reaches. As the drought permit will result in a reduction in discharge from the reservoir implementation is not anticipated to increase the range of New Zealand Pigmy weed within the Aled catchment. Therefore the impacts are assessed as **negligible**.

Summary

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

[21] Lansdown R. V. (2015) GB Non-Native Species Secretariat Factsheet: New Zealand Pigmyweed, *Crassula helmsii*. Available at http://www.nonnativespecies.org/factsheet/downloadFactsheet.cfm?speciesId=1017, Accessed 25 October 2016.

Table D4.1 Summary of Impacts on Invasive Species

Species	Impact	Significance of Impact
Reaches 1 – 3		
New Zealand pigmyweed *Crassula helmsii*	• The drought permit will result in a reduction in discharge from the reservoir and implementation is not anticipated to increase the range of New Zealand Pigmy weed within the Aled catchment	**Negligible**

D5 LANDSCAPE AND RECREATION

D.5.1 Landscape and Recreation

D.5.1.1 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. Llyn Aled and Aled Isaf reservoirs are popular locations for recreational fishing.

D.5.1.2 Assessment

Changes to water levels and wetted width in the Afon Aled 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 impacts are assessed with limited data as having a negligible risk.

The hydrological impact on Llyn Aled and Aled Isaf reservoirs has been assessed as minor beneficial, and as such no impact on recreational fishing in Llyn Aled and Aled Isaf is anticipated.

Summary

The potential impacts of the Aled Isaf drought permit on landscape and recreation are summarised in **Table D5.1**. 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 landscape and recreation. The impacts presented in **Table D5.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D5.1 Summary of Impacts on Landscape and Recreation

Feature	Impact	Significance of Impact
Reaches 1 – 3		
Landscape	• Flows during drought conditions will naturally be low therefore the implementation of the drought permit is not expected to lead to any material additional landscape and visual amenity impacts	**Negligible**
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**