Dŵr Cymru Welsh Water

Environmental Assessment of Preseli Drought Order (8206-2)

Final

March 2019

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NON-TECHNICAL SUMMARY

INTRODUCTION AND PURPOSE OF THIS REPORT

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

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

The objective of this report is to provide an independent and robust assessment of the potential environmental effects of implementing a drought order at Rosebush Reservoir, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Rosebush Reservoir is located in Welsh Water's Pembrokeshire Water Resource Zone (WRZ) which covers the far south west corner of Wales, stretching from Pendine Sands in the east to the Pembrokeshire Coastal National Park in the west, and from the village of Manobier in the south to Fishguard in the north. Water from Rosebush reservoir discharges into the Afon Syfynwy, a tributary of the Eastern Cleddau. Both rivers are components of the Eastern Cleddau Special Site of Scientific Interest (SSSI) therefore consideration has been given to the potential impacts of drought order implementation on the features and species of these designated sites.

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

This report is a 'shelf-copy' report which would be updated to support an application to the Welsh Ministers for the Preseli drought order, which may be required by Welsh Water in the future.

PROPOSED DROUGHT ORDER DETAILS

In order to protect public water supplies within Welsh Water's Pembrokeshire WRZ in the event of a future severe drought, Welsh Water would make an application to Welsh Ministers for a drought order to vary the conditions of abstraction from Rosebush reservoir.

If granted, the drought order involves a reduction in the statutory compensation

release from Rosebush Reservoir to the Afon Syfynwy from 1.82Ml/d to 0.91Ml/d. This will conserve the longevity of reservoir storage for use in direct supply during a drought, and improve the probability of reservoir refill during the winter. The drought order scheme will influence the downstream Afon Syfynwy downstream of Rosebush Reservoir outfall to the Llys-y-Fran Reservoir, an on-line impounding reservoir downstream on the Afon Syfynwy.

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

The revised abstraction arrangements would legally be authorised for four months (August-November) but would be removed sooner if water resources have returned to adequate levels to safeguard future water supplies, as agreed with the Welsh Ministers / Natural Resources Wales (NRW).

NEED FOR THE DROUGHT ORDER

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

The justification for the drought order 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 order application.

ALTERNATIVE SOURCES CONSIDERED

Details of alternative sources considered by Welsh Water will be completed at the time of application for the drought order at Preseli. This will demonstrate justification for the proposed drought option details applied for.

POTENTIAL IMPACTS OF DROUGHT ORDER IMPLEMENTATION

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

Summary of the Hydrological Assessment

The assessment has concluded that there is a **major** impact on flows in the Afon Syfynwy as a result of implementing the drought order. These hydrological impacts are assessed as leading to **minor** impacts on the physical environment of the river, including water quality.

Summary of the Environmental Features Screening

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

Screening identified WFD Status and Community Assessment / Environment (Wales) Act Section 7 Species as environmental features for which an environmental assessment was required. The assessment has concluded that there are **major-moderate** impacts on fish, and moderate impacts on macroinvertebrates, macrophytes and phytobenthos.

The HRA Stage 1 Screening concluded likely significant effects on the brook and river lamprey, and bullhead populations within the Cleddau Rivers SAC / SSSI. .

Cumulative Impacts

No cumulative effects of implementing the drought order with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for the Preseli drought order.

MITIGATION AND MONITORING

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

CONCLUSIONS

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought order at Preseli during August to November inclusive, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **major**.

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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 order by Dŵr Cymru Welsh Water (Welsh Water) to reduce the total flow release from Rosebush Reservoir to the Afon Syfynwy by 0.91Ml/d. Water stored at Rosebush Reservoir is used to provide public water supplies to Welsh Water's Pembrokeshire Water Resource Zone (WRZ) (see Section 2.1).

This EAR is a 'shelf-copy' report which would be updated in the event that Welsh Water needs to make an application during any future drought to Natural Resources Wales (NRW) for a drought order at Rosebush Reservoir. A drought order 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 order 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 order over the months of August to November inclusive, the period for which Welsh Water has determined it might require a drought order for this water source. The purpose of the assessment is to determine the environmental impacts of the drought order over and above any effects arising from natural drought conditions.

The study area and focus of this environmental assessment of the Preseli drought order, covers the following waterbodies:

- Afon Syfynwy (GB110061038300) Syfynwy - Headwaters to Llys-y-Fran

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 order (**for a summary, see Section 4 of this report**)
- identification of the environmental features that are sensitive to these changes and an assessment of the likely impacts on these features (**see Section 5 of this report**)
- identification of mitigation measures that may be required to prevent or reduce impacts on sensitive features (**see Section 6 of this report**)
- recommendations for baseline, in-drought and post-drought order monitoring requirements (**see Section 10 of this report**).

The environmental assessment has been conducted in accordance with Government regulations and using the Welsh Government / Natural Resources Wales Drought Plan

Guideline[1] (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders[2].

Consideration has been given to the potential impacts of drought order 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 order may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other relevant activities and plans. This is discussed further in Sections 3 and 7.

1.2 SUPPORTING STUDIES

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

Box 1: Drought Plan Guidance - requirement for environmental assessment

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

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

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

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

[2] Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, https://www.gov.uk/government/collections/apply-for-a-drought-permit-drought-order-or-emergency-drought-order Accessed 21 December 2018.

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 order at Rosebush Reservoir, 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 order.

1.4 STRUCTURE AND CONTENT OF THE REPORT

This EAR comprises the following sections:

Section 1: Introduction

Section 2: Background to the Drought Order

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: Impacts on Statutory Designated Sites

Section 10: Environmental Monitoring Plan (EMP)

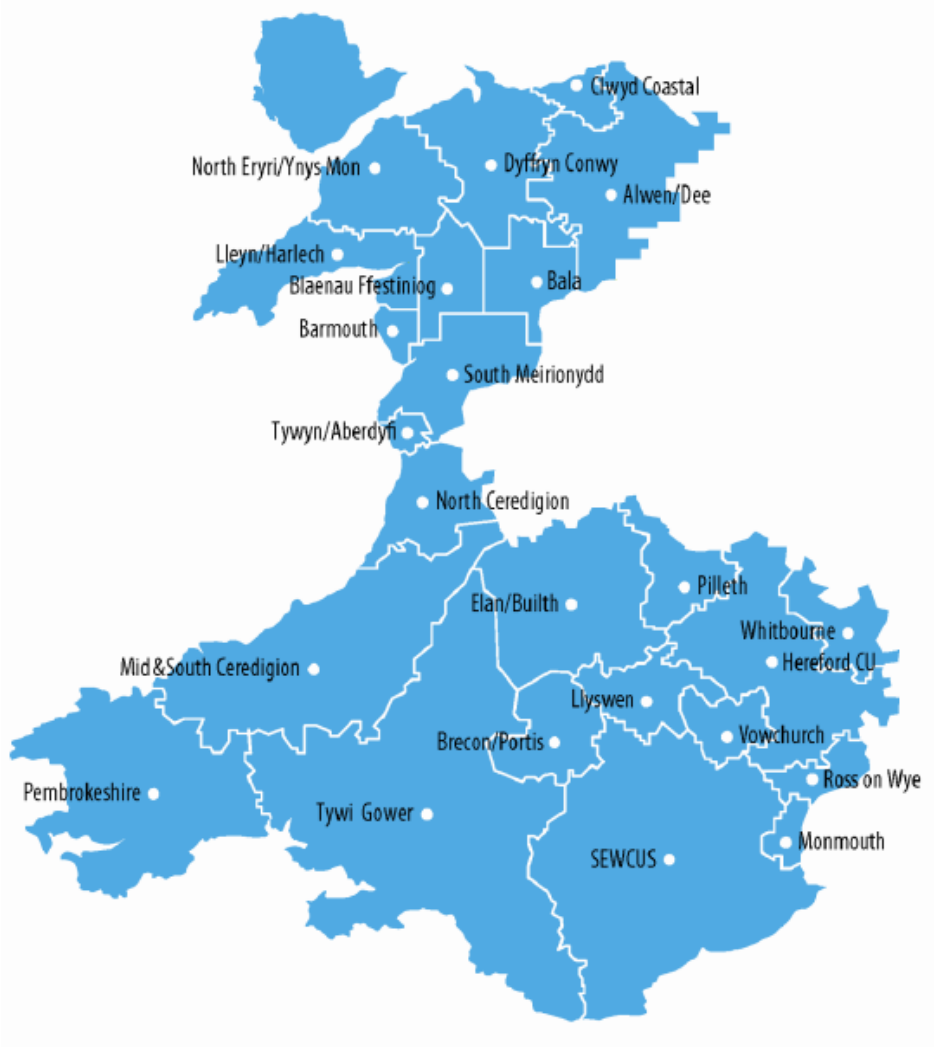
Section 11: Conclusions

2 BACKGROUND TO THE DROUGHT ORDER

2.1 WELSH WATER'S SUPPLY SYSTEM

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

Figure 2.1 Welsh Water Water Resource Zones

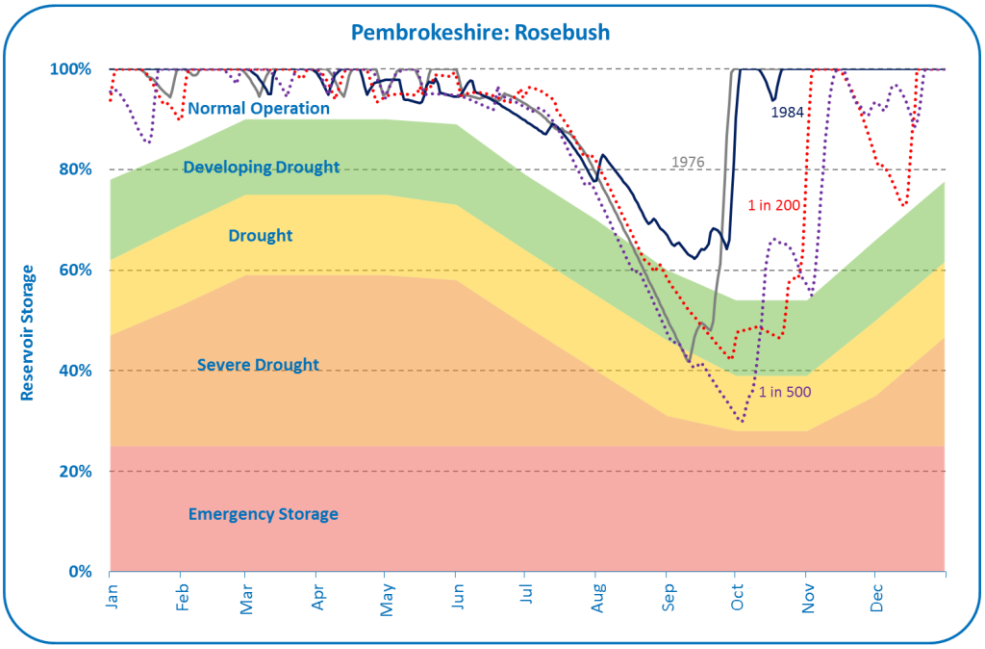


The Pembrokeshire WRZ covers the far south west corner of Wales, stretching from Pendine Sands in the east to the Pembrokeshire Coastal National Park in the west, and from the village of Manobier in the south to Fishguard in the north.

The trigger levels for applying for a drought order at Rosebush Reservoir are based on water levels falling below a defined threshold level as shown in **Figure 2.2** (orange shading labelled '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 Pembrokeshire WRZ : Preseli Drought Action Zones and Historic Droughts



2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT ROSEBUSH RESERVOIR

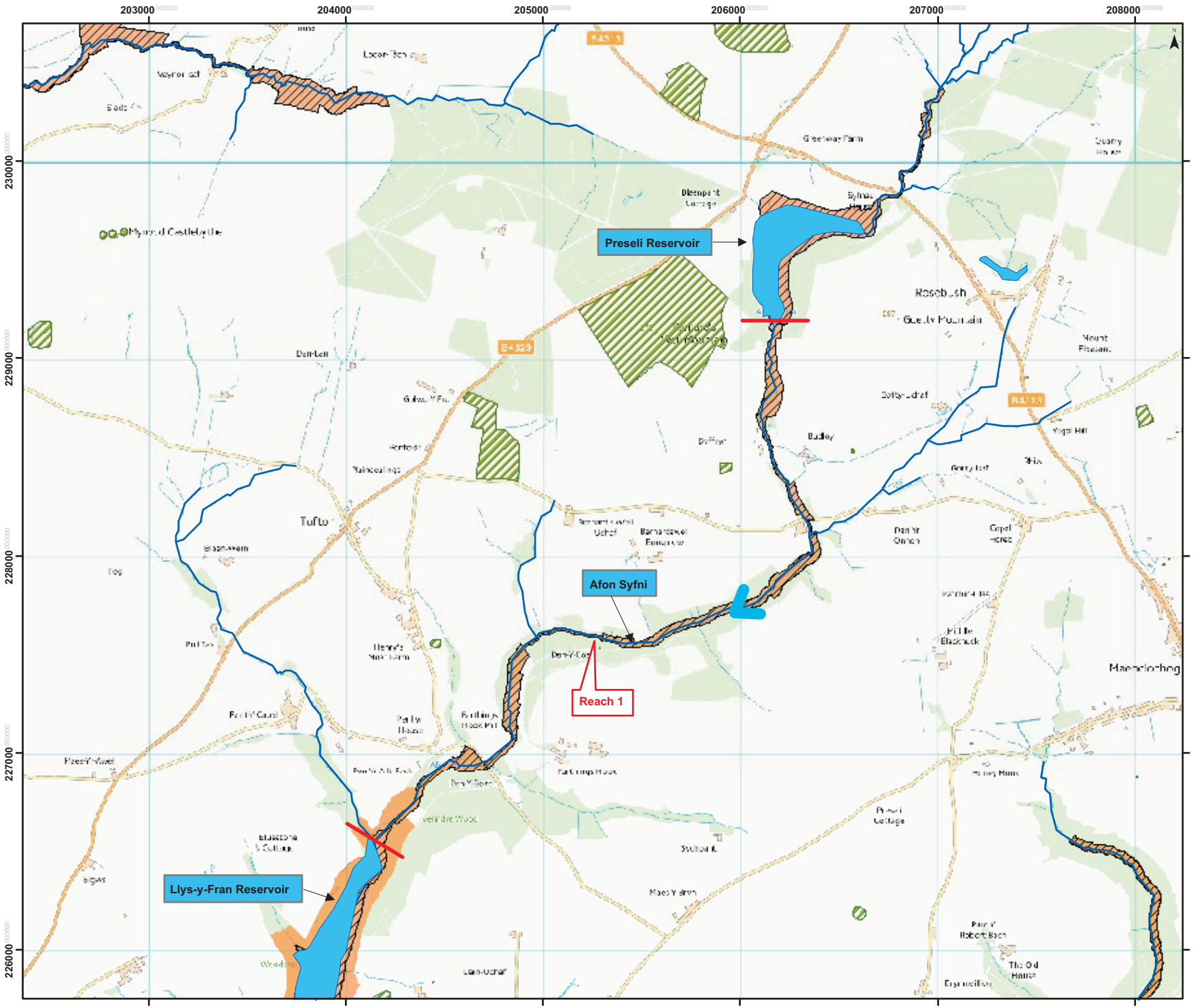
Welsh Water's licence (number 22/61/4/0001) to abstract water under the Water Resources Act at Rosebush Reservoir (see Figure B1.1) includes the following conditions:

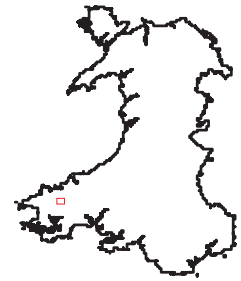
- 5,910 million litres (Ml) authorised to be abstracted per annum in aggregate total from two sources:
    - Rosebush Reservoir
    - Afon Syfynwy (upstream of Rosebush Reservoir) at Mynydd-du
- At an abstraction rate at Rosebush Reservoir not exceeding 18.2Ml/d.
- At an abstraction rate at Mynydd-du (Afon Syfynwy) not exceeding 0.045Ml/d.
- Provision of a uniform statutory compensation water discharge to the Afon Syfynwy of 1.82Ml/d at all times.

The Rosebush Reservoir abstraction is made directly from the reservoir and is piped to the nearby Preseli Water Treatment Works (WTW) for treatment, from where it is put into supply.

Welsh Water hold an additional licence (number 22/61/4/3) to abstract water from the River Eastern Cleddau at the Pont Hywel intake, subject to operating rules in Rosebush Reservoir. Water abstracted under this licence is pumped to Rosebush Reservoir to supplement storage. The drought order would not impact this licence.

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





Legend

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

RICARDO

Dŵr Cymru Welsh Water

1:18,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
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Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Study Area: 8206_2 Preseli Reservoir

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 ORDER

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

2.5 DROUGHT ORDER– 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 order, setting out the alternative options to the drought order that Welsh Water has considered in addressing the risks to essential public water supplies due to drought.

2.7 PROPOSED DROUGHT ORDER DETAILS

In order to protect essential public water supplies within Welsh Water's Pembrokeshire WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought order to vary the conditions of its abstraction licence from Rosebush Reservoir.

If granted, the drought order involves a proposed reduction in the statutory compensation release from Rosebush Reservoir to the Afon Syfynwy from 1.82Ml/d to 0.91Ml/d. This will conserve the longevity of reservoir storage for use in direct supply during a drought, and improve the probability of reservoir refill during the winter. The drought order will influence the downstream Afon Syfynwy downstream of Rosebush Reservoir outfall to the Llys-y-Fran Reservoir, an on-line impounding reservoir downstream on the Afon Syfynwy. The study area is shown on Figure B1.1.

The timing of the reduction in the compensation release is most likely to occur during the summer and autumn period, considered to not extend outside the period August to November. This has been confirmed by Welsh Water's water resources modelling.

Table 2.1 Preseli Reservoir Existing and Proposed Drought Order Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Order Abstraction	Benefit Ml/d

Rosebush Reservoir	SN062296	Welsh Water's licence (number 22/61/4/0001) to abstract water under the Water Resources Act at Rosebush Reservoir (see Figure B1.1) includes the following conditions:
		• 5,910 million litres (Ml) authorised to be abstracted per annum in aggregate total from two sources:
		  o Rosebush Reservoir.
		  o Afon Syfynwy (upstream of Rosebush Preseli Reservoir) at Mynydd-du.
		• At an abstraction rate at Rosebush Reservoir not exceeding 18.2Ml/d.
		• At an abstraction rate at Mynydd-du (Afon Syfynwy) not exceeding 0.045Ml/d.
		• Provision of a uniform statutory compensation water discharge to the Afon Syfynwy of 1.82Ml/d at all 1.82Ml/d at all times.
		
		The Rosebush Reservoir abstraction is made directly from the reservoir and is piped to the nearby Preseli Water Treatment Works (WTW) for treatment, from where it is put into supply.
		
		Welsh Water hold an additional licence (number 22/61/4/3) to abstract water from the River Eastern Cleddau at the Pont Hywel intake, subject to operating rules in Rosebush reservoir. Water abstracted under this licence is pumped to Preseli Reservoir to supplement storage. The drought order would not impact this licence.
			The drought order involves a proposed reduction in the statutory compensation release from Rosebush Reservoir to the Afon Syfynwy from 1.82Ml/d to 0.91Ml/d.
			
			This will conserve the longevity of reservoir storage for use in direct supply during a drought, and improve the probability of reservoir refill during the winter. The drought order scheme will influence the downstream Afon Syfynwy downstream of Rosebush Reservoir outfall to the Llys-y-Fran Reservoir, an on-line impounding reservoir downstream on the Afon Syfynwy. The study area is shown on Figure B1.1.
			
			The timing of the reduction in the compensation release is most likely to occur during the summer and autumn period, considered to not extend outside the period August to November. This has been confirmed by Welsh Water's water resources modelling.
				0.91Ml/d

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

2.8 DROUGHT ORDER PROGRAMME

Drought orders may remain in force 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 order is restricted to August to November, 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. An order may be granted but not actually implemented if weather conditions improve or, equally, the order may only be partially implemented.

2.9 DROUGHT ORDER 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 order being implemented. For the purposes of this assessment, the “without drought order” baseline includes the continuation of abstraction from Rosebush Reservoir and from the Mynydd-du intake on the Afon Syfnwy in accordance with the abstraction licence conditions, including the continuation of a daily compensation release of 1.82Ml/d from Rosebush Reservoir.

3 APPROACH

3.1 INTRODUCTION

The DPG states that the environmental report must include:

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

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

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

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

In accordance with the DPG and the Habitats Regulations, the assessment considers how the proposed drought order 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 order 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.

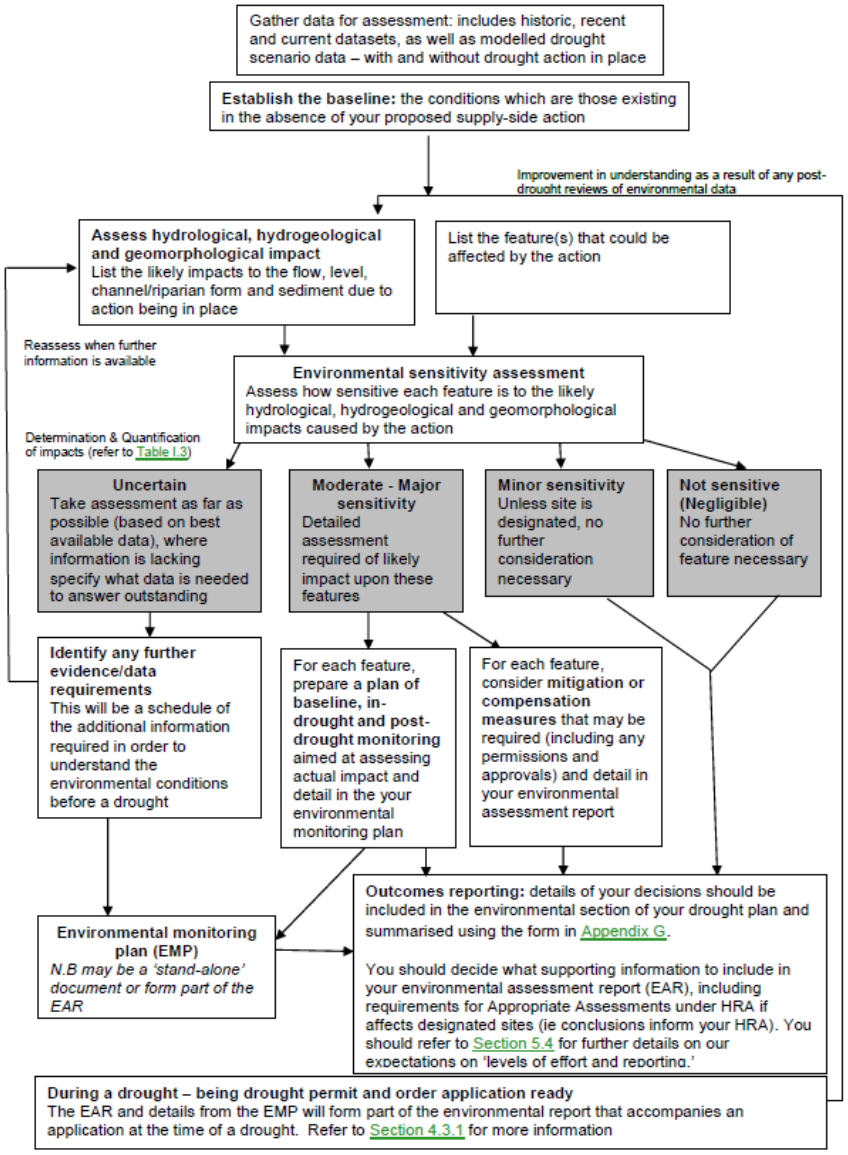
This is discussed further in Section 7.

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 order implementation should be considered in the context of what would occur without drought order implementation (see Sections 2.2, 2.7 and 2.9).

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

Stage 1 – Hydrological and Hydrogeological Impact

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

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

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

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 order. Where changes have been identified, the potential significance of adverse or beneficial impacts has been assessed.

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

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

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

Section 4 provides a summary of the hydrology and physical environment assessment as a result of implementing a drought order at Rosebush Reservoir.

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 order.

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

3.2.2 Scope

The screening exercise establishes the study area for the Rosebush Reservoir drought order together with identification of relevant, sensitive environmental features within those study areas (based on the risk of them being impacted by the drought order during the period of its operation).

As set out in **Figure 3.1**, the environmental sensitivity screening identifies the

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

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

3.3 APPROACH TO ASSESSING IMPACTS, MITIGATION AND MONITORING

3.3.1 General Approach

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

- NRW (2017) Water Company Drought Plan Technical Guideline (DPG)
- Welsh Ministers (2017) The Drought Plan (Wales) Direction
- Institute of Environmental Management and Assessment (2004) Guidelines for Environmental Assessment
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland[3]
- UKWIR (2007, updated 2012) Strategic Environmental Assessment – Guidance for Water Resources Management Plans and Drought Plans. Prepared by Cascade Consulting
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975

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

- Conservation of Habitats and Species Regulations 2017
- The Countryside and Rights of Way Act 2000.

All aspects of the drought order 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 order 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 order have been identified and described and, where appropriate, this information is used to frame and support the assessments of features which have been scoped in further to the screening and scoping exercise (see Section 3.2).

3.3.2 Assessment Methodologies

The aim of the Environmental Assessment is to provide:

- A clear summary of the outcome of each assessment (per feature) from which NRW can readily identify the significance of the impact when determining the drought order 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 order against baseline operating conditions of Welsh Water's abstraction licence in advance of drought order implementation. Environmental sensitivity has been assessed considering the context of the timing of drought order implementation. **It is important to acknowledge the basis of the assessment; i.e. impacts of drought order implementation are assessed against what would occur without drought order implementation**.

The impact assessment for sensitive features is feature specific and is dependent on

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

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

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

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

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 order.

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

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

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

3.4 LIMITATIONS OF THE ASSESSMENT AND UNCERTAINTIES

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

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

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

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

4 PRESELI DROUGHT ORDER - 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 order. **Appendix B** sets out an assessment of the potential impacts on the physical environment of Rosebush Reservoir and the Afon Syfynwy during the period of implementation of the drought order. The "without drought order" baseline is set out in Section 2.9.

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

1. It is used to "list likely changes in flow, level, channel/riparian form and sediment due to implementing the action' as required by the DPG and set out in Figure 2 of the DPG

2. It is used to support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report

3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

Each of these are summarised below.

4.2 SUMMARY OF STAGE 1 SCREENING

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

- identify any changes that the drought order 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 order;
- describe how the likely conditions would differ with the drought order 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 Rosebush Reservoir, the downstream Afon Syfynwy to the Llys-y-Fran Reservoir inflow and the Llys-y-Fran Reservoir..

2. The nature and duration of the potential impact:

A description of the likely conditions with the drought order 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 order, the key areas for the assessment of the physical environment have been identified as:

- Change in river flows downstream of Rosebush 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 order is most likely to occur during the autumn and winter period, considered to not extend outside the period August to November.

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 order 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 Order

Issue	Identified Impact
Rosebush Reservoir	
Water levels in Rosebush Reservoir *Minor beneficial impacts during drought order operation in the summer/autumn period*	• Increase in storage of up to 166Ml (over 25% of capacity) with corresponding increase in minimum water level.
Llys-y-Fran Reservoir	
Water levels in Llys-y-Fran Reservoir *Negligible impacts during drought order operation in the summer/autumn period*	• Decrease in storage of up to 166Ml, equating to around 2.1% drop in minimum water level and 2.9% increase in duration of drawdown period below top water level.
Afon Syfynwy (Reach 1)	
Flows in the Afon Syfynwy *Major impacts during drought order operation in the summer/autumn period*	• Up to 50% reduction in low flows at any time of year, with significant reductions in wetted width / wetted depth.
Geomorphology *Minor impacts during drought permit operation in the summer/autumn period*	• Minor impacts on sediment and wetted width change.
Water quality in the Afon Syfynwy *Moderate impacts during drought order operation in the summer/autumn period*	• Negligible risk to total ammonia and dissolved oxygen saturation during drought plan implementation. Moderate risk to soluble reactive phosphorus.

4.3.1 Support to the Screening and Assessment of Sensitive Features

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

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

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

5 PRESELI DROUGHT ORDER ENVIRONMENTAL FEATURES ASSESSMENT

5.1 INTRODUCTION

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

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

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

5.2 SUMMARY OF STAGE 2 SCREENING AND SCOPING

5.2.1 Designated Sites and Other Sensitive Fauna and Flora

In accordance with the DPG, **Table 5.1** identifies designated biodiversity sites (including LNR, NNR, SSSI, SAC, SPA), Environment (Wales) Act Section 7 species / habitats and other sensitive receptors that could be affected by the drought order. Susceptibility to the flow / level impacts resulting from the drought order (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 Preseli Drought Order

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)
Cleddau Rivers SAC / Eastern Cleddau SSSI	Reach 1 (Major)	The Afon Syfynwy is a major tributary of the Eastern Cleddau River, rising in the Preseli Hills, and flowing through two reservoirs, Rosebush and Llys-y-Fran. The Eastern Cleddau is a component of the Cleddau rivers SAC and flows eventually into the Milford Haven SSSI. The river flows through two reservoirs; the Rosebush and Llys-y-Fran. Implementation of the Preseli drought order would be expected to adversely impact the aquatic features thought to be present in the impacted reach (brook and river lamprey, and bullhead).	Uncertain	Yes
Notable Species – Fish Brown/Sea Trout *Salmo trutta*	Reach 1 (Major)	The Eastern Cleddau River is of special interest primarily for important populations of bullhead, river lamprey and brook lamprey. It is also of special interest for sea lamprey. Brown trout are the only species considered to be present in Reach 1 of the hydrologically impacted zone. Implementation of the Preseli drought prder would be expected to adversely impact brown trout.	Major	Yes
Notable Species – Mammals Otter *Luttra luttra*	Reach 1 (Major)	The Eastern Cleddau is one of the best rivers in Britain for otter, which are found on all the tributaries within the site. Otter are water-dependent, foraging in, over or adjacent to water for fish and aquatic invertebrates. However this species is not expected to be significantly impacted by the drought order implementation, as habitat availability and quality for otter is not anticipated to be significantly altered	Negligible	No
Notable Species – Macrophytes Water crowfoot *Ranunculus spp.*	Reach 1 (Major)	Important macrophytes present in the Eastern Cleddau include assemblages of *Ranunculon* and *Callitricho-brachion* vegetation. Within the Synfynwy between Rosebush and Llys-y-Fran Reservoirs the river is heavily shaded and consequently the diversity of aquatic vegetation is less than expected and is dominated by a few lower plants, such as brook-side feather-moss and alpine water-moss, and the alga Lemanea sp. Impacts to water crowfoot in this reach are not anticipated.	Negligible	No
Macrophyte community	Reach 1 (Major)	The major hydrological impacts in Reach 1 may reduce the availability of habitats and/or change the composition of the macrophyte community. No impacts are expected in the two reservoirs.	Moderate	Yes
Phytobenthos community	Reach 1 (Major)	The major hydrological impacts in Reach 1 may reduce the availability of habitats and/or change the composition of the phytobenthos community. No impacts are expected in the two reservoirs.	Moderate	Yes

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)
Benthic macro-invertebrate community	Reach 1 (Major)	The major hydrological impacts in Reach 1 may reduce the availability of habitats and/or change the composition of the macroinvertebrate community. No impacts are expected in the two reservoirs.	Moderate (Reach 1)	Yes
Invasive flora and fauna	Reach 1 (Major)	The implementation of the drought order is not expected to increase the distribution of invasive species which may be present within the zone of influence.	Major (Reach 1)	No
Landscape and visual amenity	Reach 1 (Major)	Preseli Reservoir and Syfynwy are located in the beautiful landscape of the Preseli Hills National Park which is designated as an Environmentally Sensitive Area (ESA) (Environment Agency Wales, 1999). The Afon Syfynwy is characterised by a steep, tree-lined, v-shaped valley. A footpath follows the Afon Syfynwy for the lower half of monitoring reach A and continues around Llys-y-Fran Reservoir. A national cycle route also crosses the study area.	Minor (Reach 1)	No
Recreation	Reach 1 (Major)	The Syfynwy catchment above Llys-y-Fran Reservoir is not accessible to migratory fish. Llys-y-Fran Reservoir is located in Llys-y-Fran Country Park and is a popular area for walkers and sailing (Environment Agency Wales, 1999). Any reduction in wetted width and depth may influence water-dependent activities. It is not expected that this short stretch of river will have any water dependant activities occurring on it. Water levels will be naturally low in times of drought and impacts will be temporary in nature and ameliorated once the drought order operation is ceased.	Minor (Reach 1)	No
Archaeology	Reach 1 (Major)	There were four Ancient monuments found with 500m of the site Budloy standing stone, Dyffryn stone circle, Castell hendre and Bernards well mountain- huts, enclosures and field systems. The implementation of this drought order is not expected to impact these monuments.	Negligible	No

5.2.2 WFD Waterbody Status

Table 5.2 identifies the WFD status classification of the WFD waterbodies that may be impacted by implementation of the drought order. Waterbodies classified as overall high / good status / potential, and / or high / good ecological status for fish or macroinvertebrates are likely to be more sensitive to flow impacts.

Table 5.2 summarises the risk to WFD status and indicates where further assessment has been carried out as reported in Section 5.3 below.

Table 5.2 WFD Status Classifications

Waterbody Name	Syfynwy = headwaters to Llys-y-fran (GB110061038800)	
Hydrological Impact at Location (Major; Moderate; Minor; Negligible)	Major	
Heavily Modified Waterbody (Y/N)	Yes	
RBMP Cycle	RBMP2 (2015)	2018 C2 Interim
Overall Ecological	Moderate	Good
Fish	High	High
Macrophytes and Phytobenthos	Not assessed	Good
Phytobenthos (Sub-Element)	Not assessed	Good
Macrophyte (Sub-Element)	Not assessed	Not assessed
Macro-invertebrates	Not assessed	High
Total P/ Phosphate	Good	High
Ammonia	High	High
Dissolved Oxygen	High	High
pH	High	High
Sensitivity (Uncertain; Moderate/ Major; Minor; Not sensitive)	Major	
Further Consideration Required (Y/N)	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 order.

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

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

5.3.2 Summary of Features Assessment

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

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

Month		J	F	M	A	M	J	J	A	S	O	N	D
Eastern Cleddau SSSI / SAC		N	N	N	N	N	N	N	N	N	N	N	N
Afon Syfynwy (Reach 1)													
Macrophytes		N/A	N/A	N/A	N/A	N/A	N/A	N/A			N	N	N/A
Macroinvertebrates		N/A	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					N/A
Brown trout	Adult habitat and migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A					N/A
	Spawning life stage	N/A	N/A	N/A	N/A	N/A	N/A	N/A					N/A
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A					N/A
	Juveniles	N/A	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					N/A
Phytobenthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A			N	N	N/A

Key to Environmental Effects:

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

5.3.3 Designated Sites

Table 5.4 presents a summary of the potential impacts of the drought order 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 Order Implementation on Designated Sites

Feature	Impact	Significance of Impact
Reach 1 – Afon Syfynwy		
Eastern Cleddau SSSI and SAC management unit 13	• Impacts on otter and Ranunculion habitat as a result of reduced flows and associated changes to the physical environment	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 / potential under the WFD.

WFD Definitions

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

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

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

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

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

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

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

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

The Environment Agency[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 order on macrophyte, macroinvertebrate, phytobenthos and fish communities and WFD status is presented below. Full details, including detailed baseline information, can be found in **Appendix D**.

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

Macrophytes

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

Table 5.5 Summary of Impacts of Drought Order Implementation on Macrophytes

WFD Status/ Community	Impact	Significance of Impact
GB110061038300 Syfynwy headwaters to Llys-y-Fran Current status: Good (combined element; 2018 interim)	There is a moderate risk of short-term deterioration in status of the macrophyte component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought order	**Moderate**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Syfynwy		
Macrophytes	• Reduction in growth as a result of major impacts on water levels and flows. • Changes to community composition due to changes to flow velocities and habitat loss due to reduction in wetted width and depth. • Increase in detrimental smothering by filamentous algae levels increasing due to an increase in nutrients, increases in water temperature and decreased velocity	**Moderate**

Macroinvertebrates

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

Table 5.6 Summary of Impacts of Drought Order Implementation on Macroinvertebrates

WFD Status/ Community	Impact	Significance of Impact
GB110061038300 Syfynwy - headwaters to Llys-y-Fran Current status: High (2018 interim)	• There is a moderate risk of short-term deterioration in status of the macrophyte component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought order	**Moderate**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Syfynwy		
Macroinvertebrates	• Reduction in species diversity and abundance as a result of reduced recruitment. • Reduction in species diversity as a result of the loss of flow-sensitive taxa • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Reduction in species diversity as a result of deterioration to water quality	**Moderate**

Fish

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

Table 5.7 Summary of Impacts of Drought Order Implementation on Fish

WFD Status/ Community	Impact	Significance of Impact
GB110061030700 Syfynwy - Llys y Fran to confluence with Eastern Cleddau Current status: High	• There is a moderate risk of short-term deterioration in status of the fish component of the waterbody due to the minor to major adverse, short-term, temporary and reversible impacts associated with the drought order	**Moderate**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Syfynwy		
Brown / sea trout	• Delays and potential cessation of adult upstream migration due to reduced flows and a reduction in adult habitat availability	**Major**
	• Reduction in recruitment due to the reduction/loss of suitable spawning habitat	**Minor**
	• Reduced water quality	**Moderate**
	• Reduction in juvenile survival due to habitat loss.	**Major**

Phytobenthos

Table 5.8 presents a summary of the potential impacts of the drought order identified from the assessment of phytobenthos.

Table 5.8 Summary of Impacts of Drought Order Implementation on Phytobenthos

WFD Status/ Community	Impact	Significance of Impact
GB110061038300 Syfynwy - headwaters to Llys-y-Fran Current Status: Good	• There is a moderate risk of short-term deterioration in status of the phytobenthos component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought order	**Moderate**
Feature	**Impact**	**Significance of Impact**
Phytobenthos	• Decrease in flow affecting phytobenthos community composition • Medium risk of deterioration to SRP affecting phytobenthos community composition and TDI score • Increases in filamentous algae smothering the substrate.	**Moderate**

6 PRESELI DROUGHT ORDER– MITIGATION

The environmental assessment has identified some significant impacts, including major hydrological impacts, minor impacts on designated sites, major aquatic ecology impacts including on fish and moderate impacts on 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 order, 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 order 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 order 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 order implementation events will provide a tool for discussions regarding best working practices between Welsh Water, NRW and any other interested parties.

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

1) measures to reduce impacts at source

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

3) management of sensitive ecological species and communities.

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

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

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

Type of Mitigation	Typical Application
Temporary reduction or cessation of the terms of the Drought Order/Permit	Where continuous water quality monitoring (typically dissolved oxygen) and/or fish distress monitoring indicate a sharp deterioration in aquatic conditions, modifications to abstraction licence conditions under the terms of the order/permit may need to be reduced or cease altogether until conditions have improved. The precise trigger levels for considering such action would be set out in discussion with NRW at the time of application taking account of the time of year and prevailing environmental conditions. Temporary cessation of the implementation of the order/permit may be required as a means of mitigating ecological effect, balanced against the need to safeguard public water supplies.
Fish distress monitoring with triggers and response plan	Regular visual observations carried out on key stretches of rivers or lakes to detect signs of large scale fish distress and agree appropriate mitigation with NRW specific to the conditions identified. This might include temporary oxygenation measures.
Protection of 'spate flows'	Temporary increases in river flows following periods of rain can be important to flush sediment/pollutants from the system or promote fish passage. Where possible, the terms of the drought order/permit could be temporarily reduced/suspended so that these spate flows are preferentially allowed to pass through the system. This decision would need to be taken in dialogue with NRW to take account of the prevailing conditions and considering the merits of encouraging fish migration during a drought.
Reduce fish predation	Consider (where feasible) a limited and targeted reduction of predation risk on fish through either the provision of refugia, in the form of artificial or natural habitat provision or improvement, or the placement of piscivorous bird scarers (in areas remote from residential locations). The merits of each option and subsequent deployment would be subject to review on a case-by-case basis in consultation with NRW.
Physical works	In some cases, temporary physical in-river works such as channel narrowing or provision of refugia could be carried out to mitigate environmental risks. If any physical works are likely to impact fish passage, appropriate mitigation measures will need to be considered as part of the design of the works.
Compensation flows	In some cases, it may be possible to use other sources of water to provide compensation flows within surface water courses to temporarily mitigate the impact of the drought order/permit
Provision of alternative water supplies	If there is a risk of derogation of other abstractors from the drought order/permit, it may be possible for Welsh Water to provide alternative water supplies or lower pumps in boreholes. Provision is otherwise provided in legislation[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 Preseli drought order are given in **Table 10.1**. 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 order 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 order with other Welsh Water supply-side and drought order options within the hydrological zone of influence (including both intra- and inter- zone options);
- Other plans and projects of relevance, including;
    - Any Welsh Water WRMP schemes which are scheduled to be implemented and become operational within the time period of the Drought Plan (i.e. before 2025).
    - Drought supply-side and drought order / permit options from NRW Drought Plans.
    - National Policy Statements for Wastewater and Renewable Energy Infrastructure.
- Environmental monitoring before, during and after drought order implementation (see Section 10).

If a drought order 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 order 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 order 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 Preseli drought order with drought order / permit schemes have been identified. However, this should be reviewed at the time of

any future application for the Preseli drought order.

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

NRW Drought Plans

No cumulative impacts of options in NRW Drought Plan with a drought order at Rosebush Reservoir are anticipated. However, this should be reviewed at time of future application for a drought order.

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 order implementation have been made in the 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 PRESELI DROUGHT ORDER - 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 order 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 order impacts.

9 HABITATS REGULATIONS ASSESSMENT: STAGE 1 SCREENING

9.1 INTRODUCTION

Under Regulation 63 of the Habitats Regulations, the competent authority (in the case of a drought order in Wales this would be Welsh Ministers, advised by NRW) is required to undertake an Appropriate Assessment of any plan / project which is likely to have a significant effect on a European site, to determine the implications for the site in view of the site's conservation objectives. The Regulations state that a person applying for any such consent (in this case Welsh Water), must provide such information as the competent authority (Welsh Ministers, advised by NRW) may reasonably require for the purposes of the assessment or to enable them to determine whether an appropriate assessment is required.

9.1.1 HRA Stages

Stage 1 – Screening

The first stage in the Habitats Regulations Assessment (HRA) is screening to determine the potential of the drought order to have a likely significant effect (LSE) on any European site (either alone or in-combination with other plans and projects) and thus if a full 'Appropriate Assessment' of any of the drought order would be required.

An in-combination assessment is carried out to establish the possibility of cumulative or synergistic impacts.

The screening stage identifies if the drought order is likely to have significant effects on European designated site, and requires Appropriate Assessment.

Stage 2 – Appropriate Assessment

Drought orders that are identified during HRA Screening (Stage 1) as having LSEs (either alone or in combination) will be taken forward to Appropriate Assessment. The Appropriate Assessment will consider the impacts of the drought order, against the conservation objectives of a European Site, in order to identify whether there are likely to be any adverse effects on site integrity and site features. The assessment will conclude whether or not the drought order, either alone or in combination with other plans and projects, would adversely affect the integrity of the European site in question. This is judged in terms of the implications of the plan for a site's conservation objectives, which relate to its 'qualifying features' (i.e. those Annex I habitats, Annex II species, and Annex I bird populations for which it has been designated). The responsibility for undertaking the Appropriate Assessment lies with the Welsh Ministers, advised by NRW.

Stage 3 – Alternative Options Stage

Where significant adverse effects are identified at the Appropriate Assessment stage, alternative options would be examined to avoid any potential damaging effects to the integrity of the European site.

Stage 4 – Assessment where adverse impacts remain

Stage 4 comprises an assessment of compensatory measures where, in the light of an assessment of Imperative Reasons of Overriding Public Interest, it is deemed that the project or plan should proceed. Imperative Reasons of Overriding Public Interest will only be progressed if no alternatives are identified as part of Stage 3.

9.2 STAGE 1 SCREENING OF PRESELI DROUGHT ORDER

The objective of this section is to bring together all relevant information to enable a screening exercise to be undertaken of the impacts of the Preseli drought order on relevant European designated sites.

These assessments have been completed in accordance with the DPG (see Section 3.3).

This section considers each of the Cleddau Rivers SAC designated features and discusses the potential for the drought order to influence their status. For species, impacts on populations range and supporting habitats and species have been considered.

9.2.1 Potential Impacts on Cleddau Rivers SAC Qualifying Features

In carrying out the screening process, the assessment has considered the main possible sources of effects on the sites arising from the potential drought order, possible pathways to the designated sites and the effects on possible sensitive receptors in the sites. Only if there is an identifiable pathway between the impacted reaches and the designated sites, or individual receptors, is there likely to be an impact and where this is absent those sites have been screened out. The screening assessment has also considered the Cleddau Rivers SAC conservation objectives. The development of conservation objectives is required by the 1992 'Habitats' Directive (92/43/EEC). In accordance with the Habitats Directive, the objectives aim to achieve the 'favourable conservation status' of habitats and species features for which SAC is designated (see **Figure 9.1**).

Site-specific conservation objectives provide a description of what is considered to be the favourable conservation status of the feature within the whole plan area. Conservation objectives for the site have been prepared by NRW.

Figure 9.1 Favourable conservation status as defined in Articles 1(e) and 1(i) of the Habitats Directive

"The conservation status of a natural habitat is the sum of the influences acting on it and its typical species that may affect its long-term natural distribution, structure and functions as well as the long term survival of its typical species. The conservation status of a natural habitat will be taken as favourable when:

- *Its natural range and areas it covers within that range are stable or increasing, and*
- *The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and*
- *The conservation status of its typical species is favourable.*

The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:

- *Population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
- *The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."*

In addition to the conservation objectives, the Core Management Plan has been used to determine LSEs against each of the specific attributes and targets for each of the qualifying features. A summary of the overall screening conclusion for each feature is provided below, with **Table 9.1** providing the assessment against each attribute and target.

Sea Lamprey

There are no records of sea lamprey within or near to the hydrological zone of impact and so this species is screened out from further consideration in this assessment with no likely significant effects.

Brook and River Lamprey

The assessment has identified the potential for impacts on brook and river lamprey as a result of a reduction in river levels and wetted width in Reach 1. All potential impacts in Reaches 2 and 3 have been screened out as the effects of the drought order implementation on river flow in these reaches has been assessed as negligible.

The reduction in wetted width in Reach 1 has the greatest potential to have a major impact as it could expose areas typically used as spawning habitats resulting in their loss or degradation. This could reduce the availability of spawning habitats, expose

eggs prior to their hatching and force fish to spawn in less favourable locations. All these could result in an impact on breeding successes and consequently the conservation status of the designated features.

A reduction in river depth and/or velocity can also impact these species especially if it occurs during the migration window (October to January). Unlike some diadromous fish species such as Atlantic salmon, river lamprey migrations are not linked to periods of increased flow however, in order to successfully migrate they still need minimum flow levels in the river.

As a result, it can be concluded that implementation of a drought order has the potential to result in likely significant effects on the populations of brook and river lamprey in Reach 1 within the Cleddau Rivers SAC.

Bullhead

Bullhead are likely to be present throughout the hydrological zone of impact. The species is flow sensitive, however, spawning and egg incubation takes place from March to May and so will likely be unaffected by reduced flows associated with implementation of a drought order. However, a reduction in the compensation flow of up to 50% is likely to have a significant impact on bullhead populations.

As a result, it can be concluded that implementation of a drought order has the potential to result in likely significant effects on the populations of bullhead in Reach 1 within the Cleddau Rivers SAC.

Otter

The assessment has identified the potential for impacts on otter as a result of a reduction in the flow velocity, wetted width and depth of the river.

There are not anticipated to be any changes to habitat or prey availability for otter as a result of drought order implementation and the drought order is not anticipated to result in likely significant effects on otter populations. Consequently, this species is screened out of the assessment with no likely significant effects.

Water Courses of Plain to Montane Levels with the Ranunculion fluitantis and Callitricho-Batrachion Vegetation

The Syfynwy in Reach 1 is heavily shaded and consequently the diversity of aquatic vegetation is lower than expected and is dominated by a few lower plants, such as brook-side feather-moss and alpine water-moss, and the alga *Lemanea* sp. This reach

is therefore not expected to represent good Ranunculion habitat, and therefore it can be concluded that the drought order will have no likely significant effects to the feature.

Alluvial Forests

Alluvial forests are not present within Management Unit 13, within which the impacted reach extends. Therefore it can be concluded that the drought order will have no likely significant effects on the feature.

Active Raised Bogs

Active raised bogs are not present within Management Unit 13, within which the impacted reach extends. Therefore it can be concluded that the drought order will have no likely significant effects on the feature.

Table 9.1 Summary of Likely Significant Effects of Preseli Drought Order Implementation Against Conservation Objectives for the Cleddau Rivers SAC

Feature	Attribute (*taken directly from NRW Conservation Objectives document*)	Site Specific Target Range and Measures	Potential Impact of Drought Order	LSE?
Sea lamprey	Distribution within the catchment	Any silt beds adjacent to or downstream of suitable spawning sites should contain *Petromyzon ammocoetes*.	No risk to achievement of conservation objective as sea lamprey not recorded in impacted reach	No
	Ammocoete density	Any silt beds adjacent to or downstream of suitable spawning sites should contain *Petromyzon ammocoetes*.	No risk to achievement of conservation objective as sea lamprey not recorded in impacted reach.	No
Brook and river lamprey	Age/size structure of ammocoete population	Samples < 50 ammocoetes 2 size classes Samples > 50 ammocoetes at least 3 size classes	Potential adverse impacts of drought order implementation on the age / size structure of ammocoete	Yes
	Distribution of ammocoetes within catchment	Present at not less than 2/3 of sites surveyed within natural range No reduction in distribution of ammocoetes	Potential adverse impacts of drought order implementation on distribution of ammocoetes	Yes
	Ammocoete density	Optimal habitat: >10m^{-2} Overall catchment mean: >5m	Potential adverse impacts of drought order implementation on ammocoete density	Yes
Bullhead	Adult densities	No less than 0.2 m-2 in sampled reaches	Potential adverse impacts of drought order implementation on adult bullhead densities	Yes
	Distribution	Bullheads should be present in all suitable reaches. As a minimum, no decline in distribution from current	Potential adverse impacts of drought order implementation on the distribution of bullhead	Yes
	Reproduction / age structure	Young-of-year fish should occur at densities at least equal to adults	Potential adverse impacts of drought order implementation on reproduction / age structure of bullhead	Yes
Otter	Distribution	Lower Limit: Otter signs found at 85% of Otter Survey of Wales full survey sites (current level: 97%) within the Eastern and Western Cleddau	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Breeding activity	2 reports (within the catchment) of otter cub/family sightings or 2 reports of cubs, lactating females or pregnant females from otter road casualties are recorded for at least 1 year in any three year period	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Actual and potential breeding sites	There should be no reduction or decline in the number or quality of identified actual	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be	No

Feature	Attribute (*taken directly from NRW Conservation Objectives document*)	Site Specific Target Range and Measures	Potential Impact of Drought Order	LSE?
		or potential breeding sites	affected by drought order	
	Water quality	To maintain and restore RE1 across catchment with no increase in pollutants potentially toxic to otters	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Food availability	Fish biomass stays within expected natural fluctuations	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Riparian habitat	No overall permanent decrease and no overall loss in sensitive areas.	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Anthropogenic mortality	No increase in numbers of recorded Road Deaths.	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
	Disturbance	No significant change to bank side usage, no significant development, particularly in sensitive areas.	No risk to achievement of conservation objective as extent of habitat and prey availability unlikely to be affected by drought order	No
Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Distribution within catchment	Distribution within site units 1, 3, 7 & 10	Impacted reach considered unsuitable to support *Ranunculion* vegetation as heavily shaded	No
	Typical species (including *Potamogeton berchtoldii* x *P. polygonifolius* – a SSSI qualifying feature)	Characteristic plant species should dominate the assemblage	Impacted reach considered unsuitable to support *Ranunculion* vegetation as heavily shaded	No
	Native species	Cover of indicators of eutrophication maintained below threshold over the medium to long term	Impacted reach considered unsuitable to support *Ranunculion* vegetation as heavily shaded	No
	Alien / introduced species	No impact on native biota from alien or introduced species	Impacted reach considered unsuitable to support *Ranunculion* vegetation as heavily shaded	No
Alluvial forests	Extent	No reduction in the total number of sites (72)	Not present within impacted reach.	No
	Quality	3 out of 4 sample woodlands on each arm of the Cleddaus to meet site-specific assessment of good condition alluvial woodland.	Not present within impacted reach.	No
	Structure and processes	The canopy is dominated by alder *Alnus glutinosa* or willow *Salix* spp. In alluvial woods with free draining soils there may be ash or oak in the canopy, but in the wetter alluvial woodlands ash *Fraxinus excelsior* will be limited to areas of relatively drier	Not present within impacted reach.	No

Feature	Attribute (*taken directly from NRW Conservation Objectives document*)	Site Specific Target Range and Measures	Potential Impact of Drought Order	LSE?
		ground. 50% - 90% of the canopy forming trees are alder. At least one example of each age component present (sapling if the survey site has a gap or woodland edge, mature, over mature, deadwood) The under-storey covers between 5-30% in at least 80% of survey sites Gaps large enough to cause a noticeable growth response from ground vegetation in >40% of survey sites Dense thickets of bramble cover <10% of individual sites and are confined to drier margins of habitat Deadwood, lying or standing > 20 cm diameter and > 1 m length present at 80% of survey sites No evidence of alder disease		
	Regeneration	Regeneration occurring and 90% alder and willow	Not present within impacted reach.	No
	Non-native species	<5% of the canopy forming trees across the woodland are non-native Exotics cover < 10% ground	Not present within impacted reach.	No
	Ground flora	60% of the survey sites should support alluvial ground flora including two of the following: meadowsweet *Filipendula ulmaria*, yellow flag *Iris pseudacorus*, nettle *Urtica dioica*, common reed *Phragmities austrailis*, greater tussock sedge *Carex paniculata*, opposite-leaved golden saxifrage *Chrysosplenium oppositifolium*, rushes *Juncus* spp, tufted hair-grass *Deschampsia cespitosa*,	Not present within impacted reach.	No

Feature	Attribute (*taken directly from NRW Conservation Objectives document*)	Site Specific Target Range and Measures	Potential Impact of Drought Order	LSE?
		hemlock water-dropwort *Onanthe crocata*, and wild angelica *Angelica sylvestris*.		
	Hydrology	Dense thickets of bramble cover <10% of individual sites and are confined to drier margins of habitat (bramble is an indicator that the site maybe drying out)	Not present within impacted reach.	No
	Grazing	No impact on regeneration and ground flora criteria satisfied	Not present within impacted reach.	No
Active Raised Bog	Extent	No reduction in extent.	Not present within impacted reach.	No
	Habitat Composition	Area of mire (2.3 ha) to be made up of the following communities: M2a at least 0.1 ha 10% of M17-M18 in I & L M18 at least 1.0 ha and, M17 upper limit 1.3 ha. Area of lagg fen (10.4 ha) to be made up of the following communities: M6: c. 1.0 ha M23: 1.8 ha M25: 7.1 ha M27: 0.3 ha S4: 0.1 ha W4: 0.1 ha		
	Indicators of negative change non-woody vascular plant species	No more than 1% cover of the following on the bog surface: *Phragmites australis*, *Phalaris arundinacea, Glyceria maxima, Epilobium hirsutum, Urtica dioica, Pteridium aquilinum, Rubus fruticosus, Juncus effusus, Deschampsia cespitosa, Cirsium* spp.		
	Development of scrub	On the mire expanse, trees and shrubs no more than rare and < 5% cover On the bog margin woody species < 10% cover		
	Drainage	Water table depths should not exceed 20 cm below ground level in an average		

Feature	Attribute (*taken directly from NRW Conservation Objectives document*)	Site Specific Target Range and Measures	Potential Impact of Drought Order	LSE?
		summer. Flooding should be confined to natural hollows only and result from rainfall and not overbank flooding		
	Atmospheric deposition	Not to exceed 10 kg N/ha/yr		

9.3 STAGE 1 SCREENING: SUMMARY

In summary, likely significant effects have been identified for the brook and river lamprey, and bullhead populations within the Cleddau Rivers SAC as a result of the implementation of the drought order.

A Stage 2 Appropriate Assessment has therefore been carried out to identify whether the implementation of the drought order will result in adverse effects on the site's conservation objectives and therefore whether the overall site integrity would be compromised. This is reported separately.

9.4 IN-COMBINATION EFFECTS

The Habitats Directive requires a consideration in the assessment of '*any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plan or projects'*.

Consideration of potential plans or projects with in-combination effects is presented in Section 7, and the Stage 2 Appropriate Assessment.

10 ENVIRONMENTAL MONITORING PLAN (EMP)

10.1 INTRODUCTION

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

- Establishing required baseline environmental monitoring and data acquisition to maintain and update the understanding of the environmental baseline conditions and to reduce uncertainties in the assessment.
- Pre-drought order monitoring describes the prevailing environmental conditions prior to drought order implementation. This will inform the implementation and management of any mitigation actions during the drought.
- During-drought order monitoring describes the environmental conditions during the implementation of the drought order. 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 order monitoring describes the recovery of environmental conditions following the cessation of a drought order, and establishes whether the affected ecosystems have recovered to conditions prevailing in the pre-drought order period.

The basis of the development of the EMP is provided in Section 10.2. Monitoring recommendations are set out in Section 10.3.

10.2 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 order 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 order monitoring aims to assess a site's recovery.
- Sites with moderate to major environmental risk should focus monitoring on those feature(s) sensitive to the likely impacts from implementing drought management actions. For Habitats Directive sites, data collected will be sufficient to demonstrate there is no adverse effect on the interest features. For SSSIs, data collected will need to be sensitive enough to pick up the likelihood of damage at the site. For WFD sites data collected will be to assess any potential 'deterioration' to status and allow you to comply with the requirements of Articles 4.6 to 4.9.
- Control sites are important to provide a comparison between the 'natural' impacts of the drought and the impacts of the drought management action.
- The EMP should include details of any surveys to support the environmental assessment, in-drought and post-drought data needs, including:
    - the feature/s to be monitored and the methods used
    - the location of survey sites
    - the timing and frequency of monitoring
    - who will undertake the monitoring.
- Separating the 'natural' impacts of a drought from those resulting from the implementation of drought management actions can be complex and made more difficult where data problems and/or a lack of hydro-ecological understanding exists. Water companies must ensure that their EMP is adequate to assess the most significant environmental impacts of its proposed drought actions and associated mitigation measures.
- The EMP needs to be agreed with NRW. Consultation with NRW should be undertaken to ensure that the monitoring proposed within the EMP to assess the potential impacts at these sites is adequate.
- A water company must provide details in the Drought Plan of likely mitigation or compensation needed against serious impacts on the environment or other water users of any proposed drought action. The EMP should assist in identifying sites that may require mitigation. In some cases, mitigation actions may be necessary to prevent derogation of other abstractions (for example, by providing alternative supplies or releasing compensation water into watercourses to limit the impact of

reduced flows).

10.3 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 order 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 order.

Recommendations for pre-drought, in drought and post-drought monitoring, based on the outcome of the current environmental assessment, are provided in **Table 10.1.** and are illustrated on **Figure 10.1**.

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

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

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

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 10.1 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)**	
N/A		Walkover survey during low flow conditions - Mapping of sensitive habitats, communities, species and any monitoring sites that are required in order to improve understanding of the baseline communities.	N/A				Welsh Water
		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
Macrophytes & Bryophytes **Reach 1**	• Reduction in growth as a result of major impacts on water levels and flows. • Reduction in abundance and distribution of taxa sensitive to nutrient enrichment (SRP) • Changes to community composition due to changes to flow velocities and habitat loss due to reduction in	The macrophyte community in the impacted reach is not well understood as a result of a lack of monitoring carried out. Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years. Carry out walkover (where survey site identification is required) and river macrophyte survey at one site in each of the impacted freshwater reaches. Follow LEAFPACS2 standard methodology. To be carried out annually during June-September, to ideally provide a three-year baseline dataset. To complement any existing	Survey to be undertaken and macrophytes identified (if drought order likely to be implemented in plant growing season). Follow LEAFPACS2 standard methodology[9]. Walkover survey to identify any key sources of nutrient loading. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorus.	Walkover of key sections known to be susceptible to lower flows, informed by pre-drought survey. If drought order implementation occurs in plant growing season, carry out macrophyte surveys at baseline sites. Follow LEAFPACS2 standard methodology for assessing macrophyte communities. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorus.	Mitigating impacts to the macrophyte community as a result of lowered flow and water level is not feasible during drought order implementation. Mitigating this impact should be triggered by post drought macrophyte community assessments to implement post drought mitigation measures. Consider measures to address identified point sources of nutrient loading. Consider scope for addressing any	In the two years following drought order implementation and in June to September monitoring period carry out LEAFPACS2 macrophyte surveys at the baseline monitoring sites. To be extended if recovery has not occurred in two years. Significant alteration to macrophyte community composition (as informed by expert judgement, based on baseline data and multivariate statistical analyses) triggers post drought mitigation actions:	Welsh Water

[9] Environment Agency (2011). Surveying freshwater macrophytes in rivers. Operational instruction 131_07. (Unpublished procedures manual)

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring Key locations	On-set of environmental drought Monitoring and trigger setting	During Drought Permit Implementation Period Trigger and monitoring to inform mitigation action	 Mitigation actions triggered by monitoring	Post Drought Permit Monitoring and post-drought mitigation (where applicable)	Responsibility
	wetted width and depth. • Increase in detrimental smothering by filamentous algae levels increasing due to an increase in nutrients, increases in water temperature and decreased velocity	NRW monitoring, in discussion with NRW.			identified sources of nutrient loading from walkover survey, if this would help address water quality risks.	If existing macrophyte community has significantly deteriorated, consider reseeding /replanting where possible to promote recovery. Replanting of macrophyte community composition to be informed by pre-drought community.	
Macroinvertebrates **Reach 1**	• Reduction in species diversity and abundance as a result of reduced recruitment. • Reduction in species diversity as a result of the loss of flow-sensitive taxa • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Alteration to community composition as a result of water	Limited NRW monitoring data is available for the site. . Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years. Monitoring sites are located at the following NRW sites: • U/S Rosebush WTW • D/S Rosebush WTW • D/S Farthings Hook Bridge	Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level. Carry out water quality surveys at same time. In severe drought conditions, no in stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level. Carry out water quality surveys at same time. In severe drought conditions, no in stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	Mitigating impacts to the macroinvertebrate community as a result of lowered flow and water level is not feasible during drought order implementation. Mitigating this impact should be triggered by post drought macroinvertebrate community assessments to implement post drought mitigation measures. Consider possible in-stream measures or adjustments to improve habitat conditions. Consider the removal of fine silt by manual raking of small areas.	In the two years following drought order implementation, 3-minute kick sampling and mixed taxon level analysis at the three routine monitoring sites. To be extended if recovery has not occurred in two years. Significant alteration to macroinvertebrate community composition (as informed by expert judgement and based on baseline data) triggers post drought mitigation actions: Targeted habitat alteration/improvements can enhance natural recovery. Habitat restoration techniques can be utilised to improve habitat quality, and flush sediment from benthic substrate.	Welsh Water

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring Key locations	On-set of environmental drought Monitoring and trigger setting	During Drought Permit Implementation Period Trigger and monitoring to inform mitigation action	 Mitigation actions triggered by monitoring	Post Drought Permit Monitoring and post-drought mitigation (where applicable)	Responsibility
	quality deterioration.					If sedimentation is deemed to be a risk to the community, consider the removal of fine silt by manual raking of small areas. If recovery of the community does not occur within two years, consider the installation of fly boards at unimpacted sites during egg laying season, before transferring the boards to the impacted reach for eggs to hatch and re-populate.	
Fish (including brown trout) **Reach 1**	Loss of important habitats (spawning gravels, nursery habitat, resting pools) Increased mortality (density dependant) as a result of increased predation and competition Stranding of individuals as a result of a reduction in wetted width/depth Fragmentation of habitats and increased	Fish populations are not well understood as a result of a lack of recent NRW and Welsh Water monitoring. Quantitative electric fishing surveys to be carried out at historic monitoring sites outlined in Section D3.3.1 and an appropriately located control site (to be identified during walkover survey outlined above). Surveys to be repeated every three years. Monitoring sites are located at: • Control site x1 • between Rosebush and Llys y Fran Reservoirs (NGR SN063282)	Electric-fishing surveys to monitor fish populations at two sites in each of the impacted reaches. If identified during baseline surveys, quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. Two sites 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:	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	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]	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. If identified during baseline surveys, quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. Two sites in each of the impacted reaches. The results of the fish	Welsh Water

[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)**	
	significance of obstacles/barriers Changes in flows and water levels may delay or prevent passage over barriers to migration Alteration to species distribution and abundance as a result of water quality deterioration. Mortality as a result of water quality deterioration (e.g. oxygen stress)	• upstream of Rosebush (NGR SN068298) Lamprey believed to be absent from Reach 1, however, if they are recorded during quantitative fish surveys, lamprey-specific electric fishing surveys targeting optimal and sub-optimal habitats are recommended. Two sites in each of the impacted reaches.	• Identification of key habitats which are at risk of fragmentation. • Identification of key structures which may provide a barrier at lower flows. • Identification of key spawning locations recording the number of redds potentially affected, undertaken during the salmonid winter spawning period (depending on order being implemented during the salmonid winter spawning period). Record extent of exposed marginal habitats, spawning habitats, composition of the bed substrate and estimates of overlaying silt cover. 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	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 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 adult trout migration (late summer/autumn). 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.	• Targeted installation of woody debris features to increase localised flow velocity/scour at impacted spawning gravels (to aid 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 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.	population surveys should help inform mitigation, targeting habitat restoration where deemed to be appropriate to support and enhance affected populations. Walkover of key spawning 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	

[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

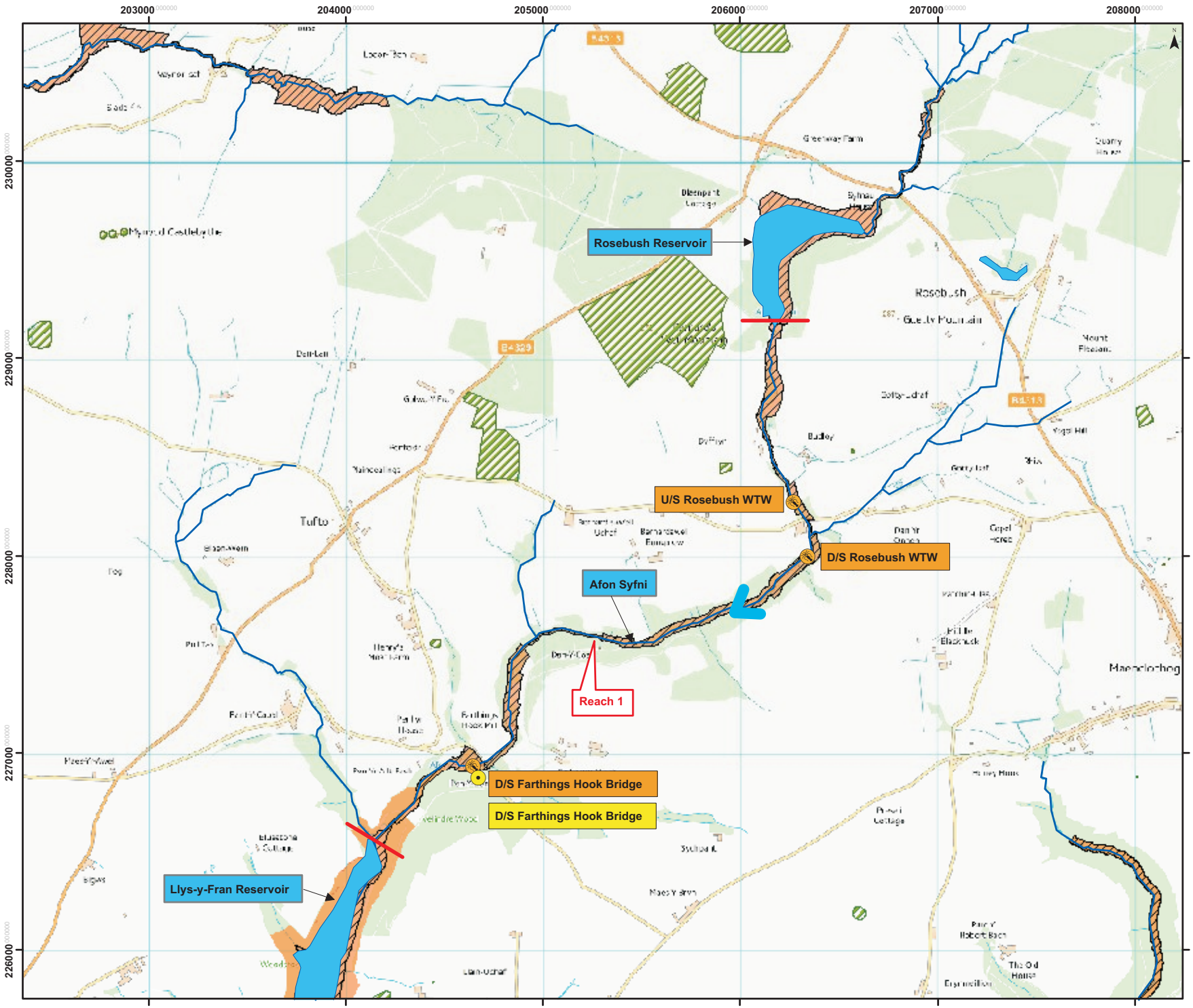
Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	**Monitoring and trigger setting**	**Trigger and monitoring to inform mitigation action**	**Mitigation actions triggered by monitoring**	**Monitoring and post-drought mitigation (where applicable)**	
			for spawning habitats based on local circumstances, timing, seasonality and expert opinion.	Deployment of automated water quality equipment that continuously monitors for dissolved oxygen.	• Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover surveys. Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW. 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	heterogeneity/scour and marginal cover in shallow areas of the channel[13] • increase localised flow velocity/scour at impacted spawning gravels (to aide 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 adult trout migration (late summer/autumn). • Modify any impacted fish passes	

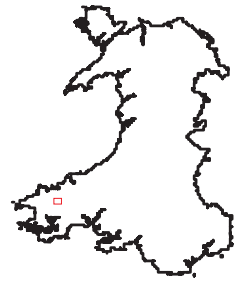
[13] Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf

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)**	
					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 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).	(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 design and installation).	
Eastern Cleddau SSSI/SAC	Impacts on designated site features assessed as **Negligible**	Lamprey and bullhead (SAC features) believed to be absent from Reach 1, however, if they are recorded during quantitative baseline fish surveys, a monitoring programme in accordance the appropriate guidance documents[14,15]					Welsh Water
Phytobenthos **Reach 1**	Decrease in flow affecting	Temporal data is limited for the impacted reach. Sampling	Sampling according to DARLEQ2protocol, at baseline	Sampling according to DARLEQ2protocol, at	No additional measures specified.	Sampling according to DARLEQ2protocol, at	Welsh Water

[14] Life in UK Rivers (2003). Conserving Natura 2000 Rivers Monitoring Series No. 5 - Monitoring the River, Brook and Sea Lamprey.
[15] Life in UK Rivers (2003). Conserving Natura 2000 Rivers Monitoring Series No. 4 - Monitoring the Bullhead.

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)**	
	phytobenthos community composition. Medium risk of deterioration to SRP affecting phytobenthos community composition and TDI score. Increases in filamentous algae smothering the substrate.	according to DARLEQ2 protocol, one sites in Reach 1 and one site in Reach 2 (control) at least 1 year, ideally 2-year baseline, ideally encompassing 1 x "normal" flow year and 1 x "dry" flow year, 2 x sampling per year, in spring and autumn. Monitoring sites are located at the following sites: • NRW site: D/S Farthings Hook Bridge • x1 control site should also be included (Reach 2).	survey sites, in spring and autumn.	baseline survey sites, in spring and autumn.		baseline survey sites, in spring and autumn.	





Legend

- Water Courses
- Hydrological Reach
- Flow Direction
- Reservoir
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments
- Macroinvertebrate Survey Site
- Phytobenthos Survey Site

RICARDO

Dŵr Cymru Welsh Water

1:18,000

Note: All locations are approximate

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Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Monitoring: 8206-2 Preseli Drought Order

Figure Number: Figure 10.1

Date: February 2019

11 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Preseli drought order. If granted and implemented, the drought order would enable Welsh Water to reduce the total flow release to the Afon Syfynwy by 0.91Ml/d, conserving storage in the reservoir.

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 order (Stage 2).

The assessment has concluded that there is a **major** impact on flows in the Afon Syfynwy as a result of implementing the drought order. These hydrological impacts are assessed as leading to **minor** impacts on the physical environment of the river, including water quality.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified WFD Status and Community Assessment / Environment (Wales) Act Section 7 Species and the Cleddau Rivers SAC / Eastern Cleddau SSSI as environmental features for which an environmental assessment was required. The assessment has concluded that there are **major** impacts on fish, moderate impacts on macroinvertebrates, macrophytes and phytobenthos. Impacts on the Eastern Cleddau SSSI were assessed as negligible.

The HRA Screening could not conclude that implementation of a drought order would not result in likely significant effects on the brook and river lamprey and bullhead populations and macrophyte within the Cleddau Rivers SAC.

No cumulative effects of implementing the drought order with existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for the Preseli drought order.

The environmental assessment has identified significant impacts of implementation of a drought order at Preseli. Consequently, in line with the DPG, mitigation measures have been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

In summary, it has been concluded that the environmental effects on river flows and ecology of implementing a drought order at Rosebush Reservoir, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **major**.

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.

<u>Perennially flowing watercourse hydrological methodology</u>

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 potential impacts on the physical environment of the Rosebush Reservoir and the downstream Afon Syfynwy catchment during the period of implementation of the Rosebush Reservoir drought order.

For the purposes of this assessment, the "without drought order" baseline includes the continuation of Welsh Water's existing abstraction and compensation flow release arrangements at Rosebush Reservoir, with the statutory compensation flow release rate set to 1.82Ml/d. The assessed drought order involves a reduced rate of compensation flow release of 0.91Ml/d.

B.1.1 Welsh Water's Existing Operations

Welsh Water's licence (number 22/61/4/0001) to abstract water under the Water Resources Act at Rosebush Reservoir (see **Figure B1.1**) includes the following conditions:

- 5,910 million litres (Ml) authorised to be abstracted per annum in aggregate total from two sources:
  - Rosebush Reservoir.
  - Afon Syfynwy (upstream of Rosebush Reservoir) at Mynydd-du.
- At an abstraction rate at Rosebush Reservoir not exceeding 18.2Ml/d.
- At an abstraction rate at Mynydd-du (Afon Syfynwy) not exceeding 0.045Ml/d.
- Provision of a uniform statutory compensation water discharge to the Afon Syfynwy of 1.82Ml/d at all times.

The Rosebush Reservoir abstraction is made directly from the reservoir and is piped to the nearby Preseli Water Treatment Works (WTW) for treatment, from where it is put into supply.

Welsh Water hold an additional licence (number 22/61/4/3) to abstract water from the River Eastern Cleddau at the Pont Hywel intake, subject to operating rules in Rosebush reservoir. Water abstracted under this licence is pumped to Preseli Reservoir to supplement storage. The drought order would not impact this licence.

B.1.2 Welsh Water's Proposed Drought Permit Operations

The drought order involves a proposed reduction in the statutory compensation release from Rosebush Reservoir to the Afon Syfynwy from 1.82Ml/d to 0.91Ml/d. This will conserve the longevity of reservoir storage for use in direct supply during a drought, and improve the probability of reservoir refill during the winter. The drought order scheme will influence the downstream Afon Syfynwy downstream of Rosebush Reservoir outfall to the Llys-y-Fran

Reservoir, an on-line impounding reservoir downstream on the Afon Syfynwy. The study area is shown on **Figure B1.1**.

The timing of the reduction in the compensation release is most likely to occur during the summer and autumn period, considered to not extend outside the period August to November. This has been confirmed by Welsh Water's water resources modelling.

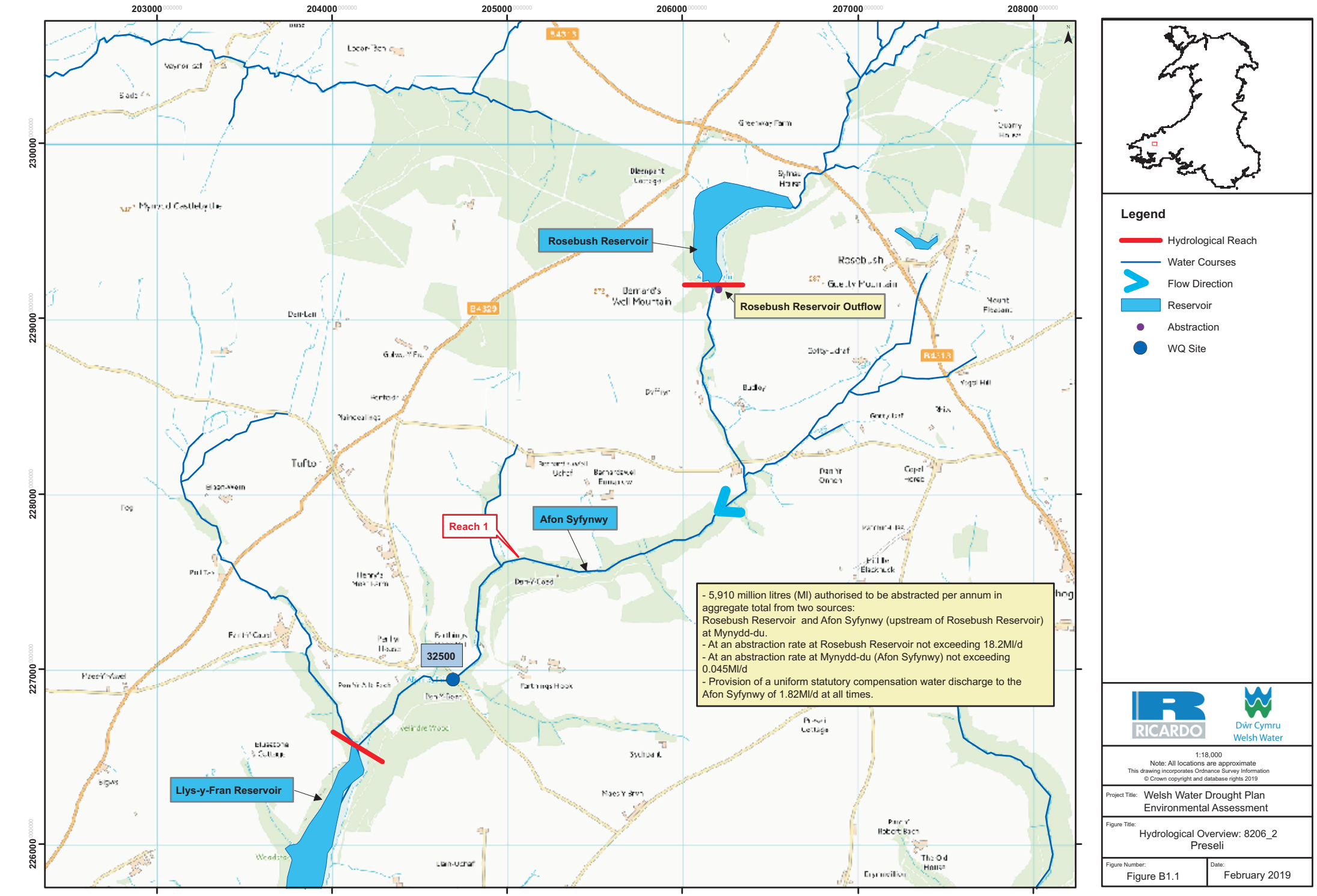
The physical environment includes consideration of hydrology and hydrodynamics, geomorphology and water quality. The assessment has three principal objectives:

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. 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 the main report.
3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

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.


203000
204000
205000
206000
207000
208000
230000
229000
228000
227000
226000
Rosebush Reservoir
Rosebush Reservoir Outflow
Afon Syfynwy
Reach 1
32500
Llys-y-Fran Reservoir
- 5,910 million litres (Ml) authorised to be abstracted per annum in aggregate total from two sources: Rosebush Reservoir and Afon Syfynwy (upstream of Rosebush Reservoir) at Mynydd-du.
- At an abstraction rate at Rosebush Reservoir not exceeding 18.2Ml/d
- At an abstraction rate at Mynydd-du (Afon Syfynwy) not exceeding 0.045Ml/d
- Provision of a uniform statutory compensation water discharge to the Afon Syfynwy of 1.82Ml/d at all times.
Legend
Hydrological Reach
Water Courses
Flow Direction
Reservoir
Abstraction
WQ Site
RICARDO
Dŵr Cymru Welsh Water
1:18,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
© Crown copyright and database rights 2019
Project Title: Welsh Water Drought Plan Environmental Assessment
Figure Title: Hydrological Overview: 8206_2 Preseli
Figure Number: Figure B1.1
Date: February 2019

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

The Afon Syfynwy rises in the Preseli mountains, 25km north-east of Haverfordwest in Pembrokeshire, South Wales. The Afon Syfynwy is impounded by two reservoirs, the Rosebush and the Llys-y-Fran Reservoirs. Rosebush (also known as Preseli Reservoir) is the upper reservoir. The Afon Syfynwy flows approximately 4.5km from the outflow of Rosebush Reservoir into the Llys-y-Fran Reservoir. Downstream of Llys-y-Fran Reservoir, the Afon Syfynwy is joined by Stepaside Brook, before itself joining the River Eastern Cleddau.

Rosebush Reservoir impoundment was constructed in 1931 and raised in 1941. The reservoir, at an altitude of 223m above ordinance datum, has a surface area of 12.18ha at top water level and a maximum usable storage volume of 644.3Ml. The 8.3km^2 catchment draining into Rosebush Reservoir has high rainfall falling on moorland heath and broadleaved and coniferous forest.

The compensation release from Rosebush Reservoir sustains flow in the upper Afon Syfynwy year round by 1.82Ml/d. Approximately 4.5km downstream of Rosebush Reservoir outflow, the Afon Syfynwy flows into a further, significantly larger on-line impounding reservoir, Llys-y-Fran Reservoir. The 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 upper Afon Syfynwy, affecting the stretch of heavily modified upland river from Rosebush Reservoir to Llys-y-Fran Reservoir.

Releases (including compensation releases) from Llys-y-Fran Reservoir to the downstream Afon Syfynwy would not be impacted by this drought order scheme. However, the reduction in compensation releases from Rosebush Reservoir will reduce inflow to Llys-y-Fran Reservoir during the drought order period, and Llys-y-Fran Reservoir has therefore been included in the study area for this assessment. The drought order conditions do not include, nor impact on, the Mynydd-du abstraction on the Afon Syfynwy.

A review of the flows and physical habitat characteristics of the river network around Rosebush Reservoir has identified the study area for this assessment. The study area includes the Afon Syfynwy, comprising one distinct hydrological reach as listed in in **Table B2.1** and identified on **Figure B1.1**.

The potential hydrological impact of the drought order has been reviewed separately for Rosebush Reservoir, Llys-y-Fran Reservoir and the single hydrological reach of the Afon Syfynwy which links the two reservoirs. This is discussed in Section B2.2.

B.2.1.2 Baseline Data Availability

Continuous monitoring is undertaken by Welsh Water to monitor its operations at Rosebush and Llys-y-Fran Reservoirs, including:

- Daily Rosebush Reservoir levels: 2003 to date.
- Weekly or daily Rosebush storage volumes: 1995 to date (excluding 2002-2003).
- Daily abstractions from Rosebush Reservoir: 1994 to date.
- Weekly or daily Llys-y-Fran Reservoir levels: 1993 to date.

The monitoring of compensation flow releases from Rosebush Reservoir to the downstream Afon Syfynwy is undertaken by Welsh Water; the data does not include overflows from the reservoir:

- Daily mean compensation release flows from Rosebush Reservoir: 2005 to date.

There are no flow measurements available for the Afon Syfynwy between the Rosebush Reservoir outflow and the Llys-y-Fran Reservoir inflow.

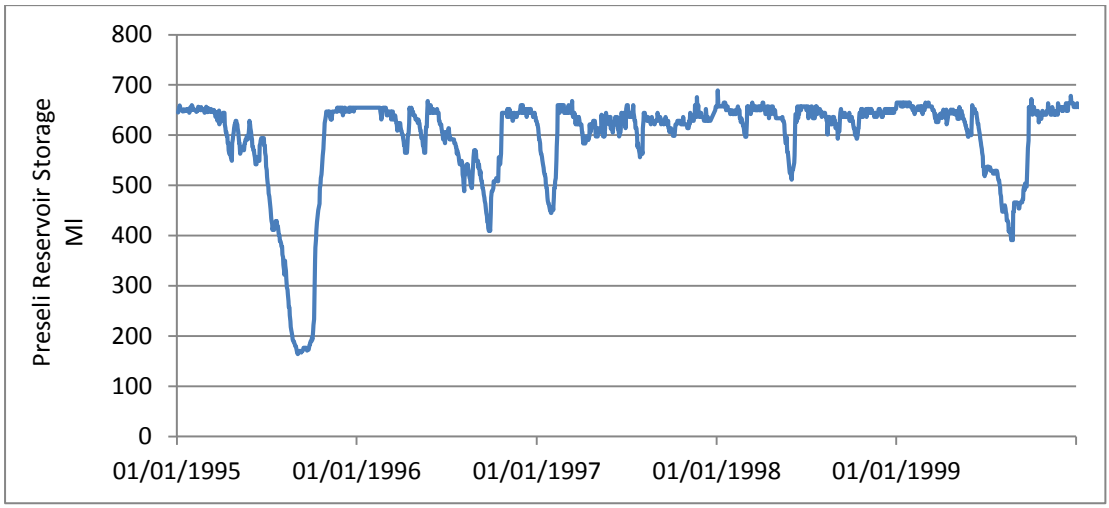
The reference conditions of the Rosebush and Llys-y-Fran Reservoirs and upper Afon Syfynwy catchment are summarised below.

B.2.1.3 Hydrology

Rosebush Reservoir

Storage in Rosebush Reservoir ranges from a minimum of 164Ml (around 25% of full capacity) to 644Ml (full) over the period 1995 to 2018. The lowest storage of 164Ml occurred on 3/9/1995, equating to a drawdown of about 3.2m below top water level. **Figure B2.1** illustrates the pattern of reservoir storage over a five-year period from 1995 to 1999, which includes some relatively dry periods. The catchment upstream of Rosebush Reservoir is flashy, and reservoir levels can rise and fall very quickly in response to rainfall events or dry periods.

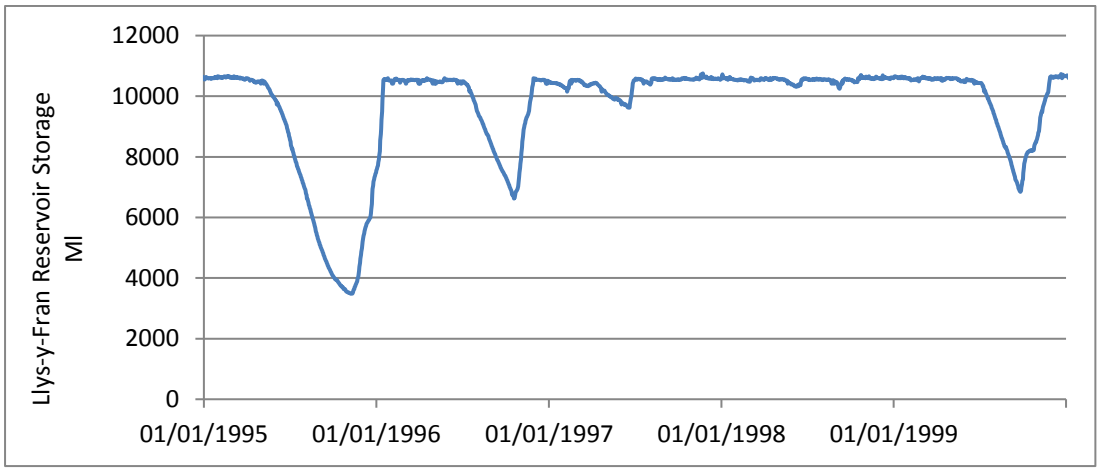
Figure B2.1 Rosebush Reservoir Storage, 1995 – 1999



Llys-y-Fran Reservoir

Storage in Llys-y-Fran Reservoir ranges from a minimum of 3481Ml (around 33% of full capacity) to 10500Ml (full) over the period 1995 to 2018. The lowest storage of 3481Ml occurred on 8/11/1995 and equates to a water level approximately 11m below top water level. **Figure B2.2** illustrates the pattern of reservoir storage over a five-year period from 1995 to 1999, as for the Rosebush Reservoir graph above.

Figure B2.2 Llys-y-Fran Reservoir Storage, 1995 – 1999



Afon Syfynwy at Rosebush Reservoir

Welsh Water operate a thin plate weir downstream of Rosebush Reservoir to measure reservoir outflows. However, from the data provided it appears that this weir only measures the statutory compensation release flow, and the measurement does not include overflows from the reservoir at times when storage is above top water level. At times when storage is below top water level, flow to the upper Afon Syfynwy is limited to the compensation release only. This occurs on about 29% of days based on the available reservoir storage data record

(which excludes most of the period 2002 to 2003). The compensation flow is maintained at the statutory level of 1.82Ml/d or above.

B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

The study area includes Rosebush Reservoir, the downstream Afon Syfynwy to the Llys-y-Fran Reservoir inflow and the Llys-y-Fran Reservoir, comprising one distinct hydrological reach as shown in **Figure B1.1**:

- Reach 1 is the Afon Syfynwy, from the Rosebush Reservoir outflow to the Llys-y-Fran Reservoir outflow.

The potential hydrological impacts of the drought order option have also been considered for Rosebush Reservoir itself and Llys-y-Fran Reservoir. **Table B2.1** provides a summary of the hydrological impacts at the end of this section, whilst the details of the assessment are presented below.

B.2.2.2 Hydrological Impact Assessment

Rosebush Reservoir

The impact on Rosebush Reservoir would be an increase in levels / storage, relative to the position without the drought order, due to the reduced outflow which would help to conserve water in storage. Storage could potentially be increased by up to 166Ml over the six month duration of the drought order, which is over 25% of the total capacity of Rosebush Reservoir. The length of time of shoreline exposure would be shorter, compared to the baseline drought scenario, as the reservoir would reach top water level earlier during the winter refill period. This would be considered as a **minor** beneficial impact and has not been assessed further.

Llys-y-Fran Reservoir

The impact on Llys-y-Fran reservoir would be a loss of up to 166Ml storage volume over the full six month period of a drought order, due to the reduced inflows from the Afon Syfynwy downstream of Rosebush Reservoir. This reduced volume is equivalent to approximately 0.4m depth of water in Llys-y-Fran Reservoir, in drought conditions when the reservoir would already be drawn down by up to 11m below top water level. A drop in minimum water levels of 0.4m equates to around a 2.1% reduction in minimum water levels (relative to a fixed datum 30m below top water level, which is believed to be the approximate height of the dam).

The length of time to refill the reservoir, compared to the baseline drought scenario, would be marginally increased. Following the 1995 drawdown event, winter refill occurred over a period of 69 days (from 8/11/1995 to 16/1/1996) at a net average rate of just over 100Ml/d. The loss of a further 166Ml of storage would therefore result in an increase of less than two days to the

overall drawdown period (a percentage increase of 2.9% in the drawdown duration).

The impact of the Rosebush Reservoir drought order on water levels in Llys-y-Fran Reservoir is therefore considered to be **negligible**.

Reach 1 – Afon Syfynwy from Rosebush Reservoir outflow to Llys-y-Fran inflow

The Afon Syfynwy in Reach 1 flows steeply (descending 120m over 4.5km) down a tree-lined, v-shaped valley in an upland area. Sediment supply to the reach is interrupted by the Rosebush Reservoir impoundment, and flow is modified through the reservoir release regime. The channel in Reach 1 is, therefore, considered to be heavily modified both in terms of flow and morphology. At low flows, flow accretion in the intervening catchment of the monitoring reach will be negligible. The monitoring reach is dislocated from the downstream Afon Syfynwy by the Llys-y-Fran Reservoir.

The compensation release would be reduced by up to 50% during drought order operation, a potentially significant local flow change, and the 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 Syfynwy. The hydrological impact of the drought order on Reach 1 has therefore been assessed as **major**.

B.2.2.3 Hydrological Impact Summary

One river reach has been considered for which the assessed hydrological impacts is **major**. The impacted reach is shown in **Table B2.1** and establishes the full in-channel zone of influence of the drought order for environmental sensitivity screening (see **Figure B1.1**).

The hydrological impact on Rosebush Reservoir itself has been assessed as **minor beneficial,** whilst the hydrological impact on Llys-y-Fran Reservoir has been assessed as **negligible**.

Table B2.1 Hydrological Reaches Identified in the Study Area

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact
		Upstream	Downstream		Summer Q_{95}	Summer Q_{99}	
Rosebush Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor beneficial**
Llys-y-Fran Reservoir		n/a	n/a	n/a	n/a	n/a	**Negligible**
1	Afon Syfynwy	Rosebush Reservoir outflow	Llys-y-Fran Reservoir inflow	4.5km	50%	50%	**Major**

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

There is little geomorphological information for the Afon Syfynwy between Rosebush Reservoir and Llys-y-Fran Reservoir. This assessment was conducted using extant aerial imagery. Geology is dominated by sandstone, mudstone and siltstones of the Arenig formation, with a small band of Ordovician tuff in the upper section of the catchment. The river is formed in alluvium and diamicton deposits.

Reach 1 – Afon Syfynwy from Rosebush Reservoir outflow to Llys-y-Fran Reservoir inflow

With an average gradient of ~2.5% and slight sinuosity, this is a steep upland river with a densely wooded riparian zone on both banks over most of the reach. Land-use is largely improved grassland. Reach morphology is deemed to be highly modified due to the Rosebush Reservoir impoundment and associated effects of flow and sediment supply.

Assessment

Due to the major hydrological impact on Reach 1, some impacts on geomorphological functioning of the reach are expected. The bedload substrate is unknown, and as the reach is situated between two reservoirs, it is assumed the substrate is limited due to the upstream reservoir trapping the sediment. Due to the upland nature, larger bed substrate is however, expected. Impacts on suspended sediment associated with implementation of the drought order are likely to be **minor**, due to the position of the reach and its upland nature. Suspended sediment may be deposited in areas of ponding, however would be removed when normal flow returns. Bedload transport will not occur during a drought, due to the amount of energy required to move larger substrate.

As the data is limited, the impacts on wetted width are assumed to be **minor** and focused on shallow areas of the channel. The tree cover along Reach 1 will provide shading and habitat opportunities for fauna, which may limit the impacts on wetted width within the reach.

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 Sewage Treatment Works (STWs)), which may cause increased deterioration in water quality with the drought order 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 order, including trends over time and with respect to river flow. For Water Framework Directive (WFD) classification, the Environment Agency has set

out[2] following UK Technical Advisory Group (UKTAG) evidence[3] what pressures, including water quality pressures, each biological quality element is capable of responding to. For the purposes of assessment here, the supporting water quality parameters are set out for fish and macroinvertebrates (where identified as sensitive features) as dissolved oxygen saturation and total ammonia concentration; and for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features) as soluble reactive phosphorus (SRP). Specifically, for macrophytes, if the hydrological impacts of drought order 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.

Ten years of NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact). Water quality data were available for one location on the Afon Syfynwy within the extent of influence of the drought order (Reach 1). There is one NRW water quality sampling site within this reach (**Table B3.1** and **Figure B1.1**). No appropriate flow data were available for Reach 1, so pairing water quality with flows has not been undertaken.

Where data are 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 Syfynwy

Reach	Site Name	NRW Site Code	Grid reference	Location
1	Afon Syfynwy at Farthings Hook	32500	SN046942694	Approximately 600m upstream of Llys y Fran inflow.

These reaches fall within the Cleddau SAC and as such have been be compared against the specific conservation objectives. The specific water quality objectives for this SAC are given in **Table B3.2**.

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

Table B3.2 – Cleddau SAC specific water quality objectives

Dissolved Oxygen	Biological Oxygen demand	Total ammonia	Unionised ammonia	pH	Phosphate
85	1.5	0.25	0.021	6-9	0.039

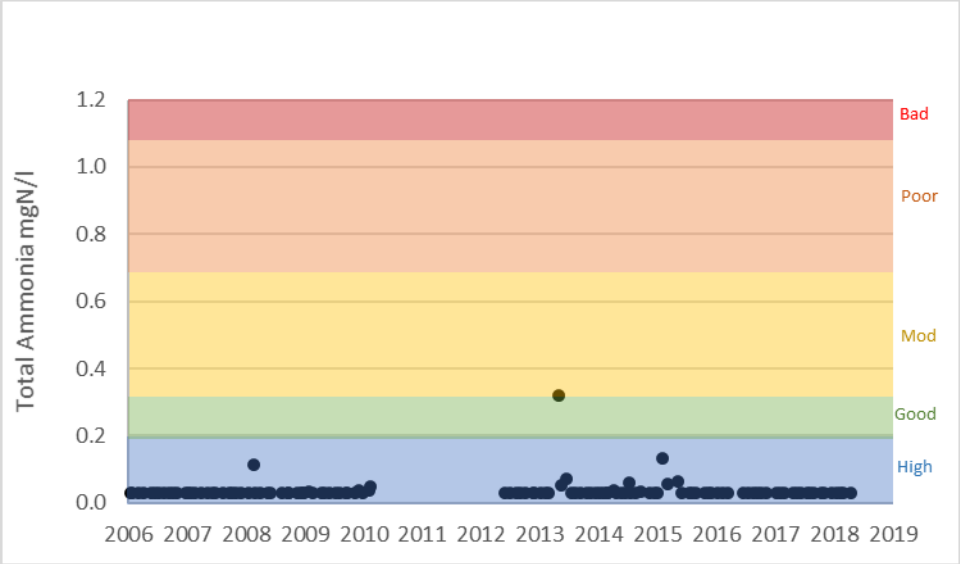
Reach 1 - Afon Syfynwy from Rosebush Reservoir outflow to Llys-y-Fran inflow

No long term monitoring data is available for this reach. Assessment has been undertaken based on water quality data from sample point Afon Syfynwy at Farthings Hook (32500). The average pH over the ten year period was 7.27 while the maximum water temperature was 15.7°C.

Total ammonia concentration

Total ammonia concentration in the Afon Syfynwy at Farthings Hook were reviewed against the relevant WFD standard for an upland low alkalinity river[4] (**Figure D3.1**). All measured values complied with the WFD standard to support high status for fish and invertebrates (0.2mg/l). One exception is noted on 31/01/2014 with 0.32mgN/l resulting in moderate WFD status. This appears to be an isolated incident. No seasonality or change over time is apparent at this location.

Figure B3.1 Total Ammonia in the Afon Syfynwy at Farthings Hook, Incorporating Appropriate WFD Status Bands

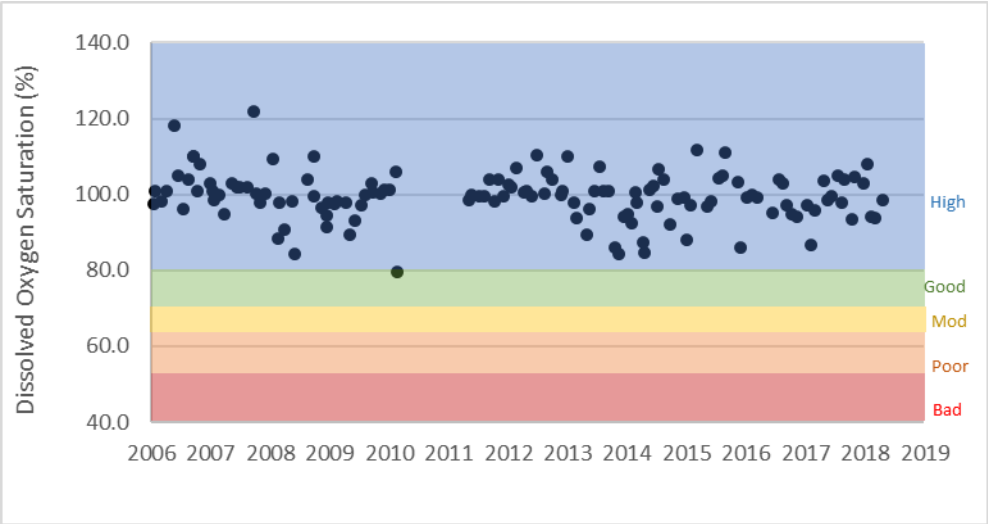


Dissolved oxygen saturation

Dissolved oxygen saturation in the Afon Syfynwy at Farthings Hook were reviewed against the relevant WFD standard for an upland low alkalinity river[5] (**Figure B3.2**). All measured values complied with the WFD standard to support good status for fish and invertebrates (75%) excluding a single measurement at 79.5% on 25/11/2010. No seasonality or change over time is apparent at this location.

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

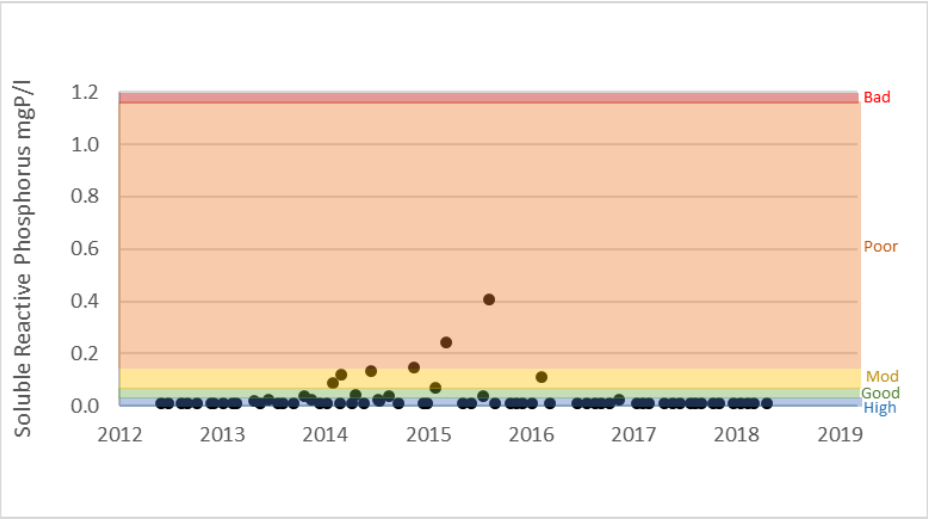
Figure B3.2 Dissolved Oxygen Saturation the Afon Syfynwy at Farthings Hook, Incorporating Appropriate WFD Status Bands



Soluble Reactive Phosphorus

Soluble reactive phosphorus concentration in the Afon Syfynwy at Farthings Hook was reviewed against the relevant WFD site specific standards provided by NRW[6] (**Figure B3.3**). Soluble reactive phosphorus concentration in the Afon Syfynwy at Farthings Hook were variable with the WFD standard to support good status for fish and invertebrates (0.03mgP/l). Values below this standard were noted in 36.7% of instances (17 occurrences). No seasonality is apparent, however an apparent decrease in water quality occurred from 2014 – 2016 however in recent years concentrations have remained low.

Figure B3.3 Soluble Reactive Phosphorus Concentration in the Afon Syfynwy at Farthings Hook, Incorporating Appropriate WFD Status Bands

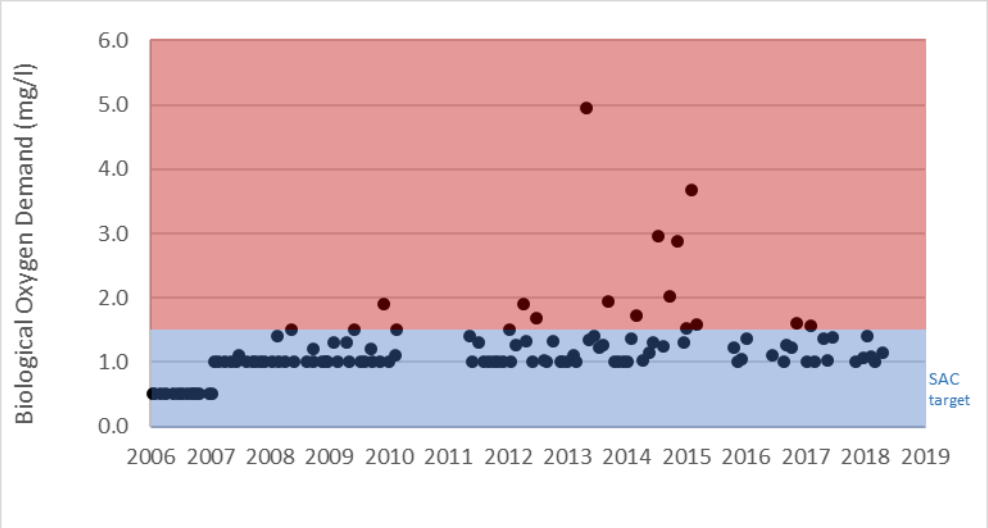


[6] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Biological Oxygen Demand

Biological Oxygen Demand (BOD) concentration in the Afon Syfynwy at Farthings Hook was reviewed against the Cleddau SAC targets (**Figure B3.4**). BOD concentrations in the Afon Syfynwy at Farthings Hook were mostly compliant with the SAC BOD targets (1.5 mg/l) however there were 14 instances where this was exceeded. While no flow data were available the sample notes indicate the peaks in BOD are largely attributed to higher flows.

Figure B3.4 Biological Oxygen Demand in the Afon Syfynwy at Farthings Hook, Incorporating Appropriate WFD Status Bands



Water Quality Summary

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

Total ammonia concentrations were all consistent with the standard to support good status for fish and invertebrates throughout the zone of influence of the Rosebush Reservoir drought order. The risk of water quality deterioration linked to total ammonia concentration within Reach 1 is therefore assessed as **low**.

Dissolved oxygen saturation measurements were all consistent with the standard to support good status for fish and invertebrates throughout the zone of influence of the Rosebush Reservoir drought order. The risk of water quality deterioration linked to dissolved oxygen saturation within Reach 1 is therefore assessed as **low**.

Soluble reactive phosphorus concentrations were mostly consistent with the standard to support good status for fish and invertebrates throughout the zone of influence of the Rosebush Reservoir drought order. It is identified that the drought order would pose a **medium** risk to water quality during drought plan implementation owing to reduced dilution of SRP inputs.

This reach falls within the Cleddau SAC and as such has been compared against the specific conservation objectives. Reaches 1 is both compliant with the targets for dissolved oxygen, un-ionised and total ammonia and pH. In Reach 1 BOD is predominantly compliant with the SAC objective however concentrations have exceeded it on 14 occasions since 2006. It is therefore assumed that the risk to deterioration against the SAC targets is **medium** in Reach 1 and 2, owing to intermittend peaks in BOD during higher flows.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

There are no licensed surface water abstractions in the study area apart from Welsh Water's abstraction from the Rosebush Reservoir intake, the subject of this assessment, and from Llys-y-Fran reservoir, which would not be impacted by the drought order.

B.3.3.2 Water Quality Pressures

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

There are two consented discharges within the study area. Preseli WTW (consent number BP0118501) has a consented daily maximum discharge of 900m^3/d. Changes in the dilution and dispersion of these discharges in the Afon Syfynwy during operation of the drought order are not considered significant.

Table B3.2 Consented Discharges in Area of Influence of the Rosebush Reservoir drought order

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 @ 105 C (mg/l)**	**Zone of influence (<500m)**	**Consideration of water quality pressure** (during baseline low flow conditions)
BP0118501	Prescelly Water Treatment Works	SN0635028120	0.75	0.014	Not specified	Not specified	100	On reach 1	Minor
BN0267001	Rosebush STW	SN0732029190	Not specified	Not specified	Not specified	Not specified	Not specified	1.5km	Negligible

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Rosebush 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 Rosebush Reservoir Drought Permit

Rosebush Reservoir	
Water levels in Rosebush Reservoir *Minor beneficial impacts during drought order operation in the summer/autumn period*	• Increase in storage of up to 166Ml (over 25% of capacity) with corresponding increase in minimum water level.
Llys-y-Fran Reservoir	
Water levels in Llys-y-Fran Reservoir *Negligible impacts during drought order operation in the summer/autumn period*	• Decrease in storage of up to 166Ml, equating to around 2.1% drop in minimum water level and 2.9% increase in duration of drawdown period below top water level.
Afon Syfynwy (Reach 1)	
Flows in the Afon Syfynwy *Major impacts during drought order operation in the summer/autumn period*	• Up to 50% reduction in low flows at any time of year, with significant reductions in wetted width / wetted depth.
Geomorphology *Minor impacts during drought permit operation in the summer/autumn period*	• Minor impacts on sediment and wetted width change.
Water quality in the Afon Syfynwy *Moderate impacts during drought order operation in the summer/autumn period*	• Negligible risk to total ammonia and dissolved oxygen saturation during drought plan implementation. Moderate risk to soluble reactive phosphorus.

B5 CUMULATIVE IMPACTS

The assessment only considers the effects of a single drought order application and not the cumulative or in-combination effects if another drought order within the same catchment were applied for and implemented concurrently. However, it is also necessary to consider the cumulative effects with other drought options which may be implemented at the same time within the Afon Syfynwy catchment and/or Pembrokeshire WRZ.

The cumulative effects of this drought order with other relevant drought options in the Pembrokeshire WRZ and/or Afon Syfynwy catchment are summarised in **Table B5.1** below.

Table B5.1 Cumulative Impacts of the Rosebush Reservoir Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the Pembrokeshire WRZ / Afon Syfynwy catchment	8206-1 (Reduce prescribed flow below Crowhill Abstraction) – The impacts of this drought management option do not occur within the same catchment and therefore no in-combination impacts are anticipated.	No
	8206-7 (Llys-y-Fran use of freshet bank) – the extent of any impact of the Preseli drought order extends until the upper end of Llys-y-Fran Reservoir. As the impacts of the 8206-7 Llys-y-Fran drought order extends from the outlet of the reservoir, the impacted areas of the two schemes do not coincide. There are no cumulative effects of these two drought orders on the downstream water environment.	No
	8206-8 (Reduced Hands-Off Flow at Canaston) –the extent of any impact of the Preseli drought order extends until the upper end of Llys-y-Fran Reservoir. As the impacts of the 8206-8 Canaston drought order extends from the outlet of the Llys-y-Fran Reservoir, the impacted areas of the two schemes do not coincide. There are no cumulative effects of these two drought orders on the downstream water environment.	No
	In combination assessment of the Preseli drought order with 8206-7 (Llys-y-Fran use of freshet bank) and 8206-8 (Canaston) – the Preseli Reservoir drought order would affect the Afon Syfynwy reaches upstream of the Llys-y-Fran Reservoir whilst the Llys-y-Fran freshet bank drought order and Canaston drought order affect the Afon Syfynwy downstream of the reservoir. The only in-combination effect from the concurrent implementation of these three drought orders relates to the potential very small increase to the duration that the Llys-y-Fran freshet bank drought order and Canaston drought order may be required due to the upstream Preseli drought order reducing inflows to Llys-y-Fran reservoir. This potential impact has been assessed as equivalent to 2 days of additional implementation of both drought orders which would not lead to any in-combination adverse effects on site integrity.	No
Natural Resources Wales - Drought options in the Afon Syfynwy catchment	No previous drought order applications have been made in the South West Wales region.	No

APPENDIX C
ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGY

A.1 ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGIES

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

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

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

Assessment sheets are included for the following features:

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

FLOW PRESSURES

Potential Effects

In support of understanding the physical environment and the risk assessment in the zone of influence of each drought option, a review will be undertaken of additional flow pressures from licensed surface water and groundwater abstractions. Relevant pressures have been identified and risk assessed in terms of in-combination flow impacts from implementation of a drought option. Abstractions have the potential to exacerbate low river flows or, in the case of groundwater-dominated catchments where rivers seasonally run dry (ephemeral watercourses), to increase the length of river that is dry and the period of time for which it remains so, potentially beyond the period for which the drought option is in place.

As a result of a drought option, there may be less water available in the zone of influence (rivers and groundwater bodies) for licence holders to abstract, and any abstractions that do occur reduce the amount of surface water available – affecting the wetted perimeter of the habitat, velocities within the wetted area and the ability to dilute any pollutants entering the system. For surface water abstractions, this includes consumptive abstraction and partially consumptive/non-consumptive abstraction – where some or all of the water is returned to the river locally after use, with the potential to reduce flow in the river if the discharge is downstream of the abstraction.

Definition of Risk

Continuously flowing watercourses

In order to define the potential risk to flow from river and groundwater abstractions in a readily understandable manner, a series of criteria have been defined. The assessment is informed by long term gauged flow data. The impact of the drought option will be considered against baseline 'drought' conditions (without drought option implementation). The assessment will use the following criteria, based on the potential severity of the risk to river water quality and flow during an ongoing drought.

- High: A major reduction in low river flows, including the influence of the drought option - typically >25% reduction in summer Q95 (with drought option in place)
- Medium: A moderate risk to low river flows (as above) , including the influence of the drought option - typically 10-25% reduction in summer Q95 (with drought option in place)
- Low: A minor risk to low river flows, including the influence of the drought option - typically <10% reduction in summer Q95 (with drought option in place)
- Negligible: Indicative of no significant change from the "without drought" option baseline situation.

Ephemeral watercourses

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

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

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

Data Requirements

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

Assessment Methodology and Uncertainty

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

Groundwater abstractions

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

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

Surface water abstractions – continuously flowing watercourses

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

Surface water abstractions – ephemeral watercourses

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

All abstractions

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

WATER QUALITY PRESSURES

Potential Effects

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

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

Definition of Risk

Continuously flowing watercourses

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

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

Ephemeral watercourses

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

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

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

Data Requirements

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

Assessment Methodology and Uncertainty

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

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

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

Continuously flowing watercourses

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

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

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

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

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

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

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

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

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

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

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

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

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

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

alkalinity rivers[5].

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

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

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

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

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

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

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

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

Ephemeral watercourses

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

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

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

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

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

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

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

WATER FRAMEWORK DIRECTIVE STATUS: FISH

Potential Effects

For WFD river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the fish element of biological status is *High* or *Good*, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the *Good* status band to the *Moderate* status band, as advised by NRW / Environment Agency.

Definition of Impacts

In order to define the potential WFD status impacts for fish in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.

- Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the fish biological element of the classification.
- Moderate: A moderate impact on fish status occurs when the fish population is predicted to be materially influenced, including effects on density, abundance or community composition, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the populations.
- Minor: A minor impact occurs when there is a predicted impact on fish abundance, density or community composition that is within the usual variability for the site and which will recover within a short timescale.
- Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the fish population.

Data Requirements

Fish status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Fish data should include species presence, abundance and density. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) as follows:

- Relevant study area (as identified in the screening report)
- Hydrology at or close to the monitoring sites to link to fish data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records
- Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges
- Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys
- Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.

Assessment Methodology and Uncertainty
The WFD classification for the waterbody will be identified and the reasons for classification established from the NRW / Environment Agency. The data used to support the assessment will be reviewed to ensure that the classification is accurate. Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These will include graphing the hydrology, water quality, habitat and fish variation temporally over the monitored period. The analysis will consider the relationship between fish status and the supporting environmental variables over the period, with an emphasis on changes to fish status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether fish status responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability. Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought option may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option. This will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth. Once the flow, habitat and water quality drought option predictions have been established, their implications for existing fish species will be assessed. The flow and habitat environmental envelope of the key fish species is known. The predicted changes in supporting environmental variables (flow, depth, velocity, habitat quality, dissolved oxygen levels and temperature) due to the drought option will be assessed against the fish population data. Where the supporting environmental variables for fish species are modified to take them outside of their preferred envelope it can be assumed that there will be a moderate or major impact on that fish population. Consideration will be given to the potential for density dependent mortality where data show that the fish population has an existing good density, and where the drought option reduces habitat availability significantly The assessment will consider the scale and longevity of any fish status impacts. The WFD classification is calculated on a 3 year rolling basis. A deterioration in classification would require a long term (2+ breeding seasons) and significant effect on fish population structure to allow prediction of a deterioration in status. Where data are not available the assessment will be undertaken using expert judgement and drawing on broad-scale evidence from other similar catchments if applicable. The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or

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

WATER FRAMEWORK DIRECTIVE STATUS: MACROINVERTEBRATES

Potential Effects

For Water Framework Directive (WFD) river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the aquatic macroinvertebrate component of ecological status is *High* or *Good*, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the *Good* status band to the *Moderate* status band.

Definition of Impacts

In order to define the potential WFD status impacts for aquatic macroinvertebrates in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.

- Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the macroinvertebrate biological element of the classification.
- Moderate: A moderate impact on macroinvertebrate status occurs when the macroinvertebrate community is predicted to be materially influenced, including reduction in the LIFE score, or in community density +/or abundance, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the community.
- Minor: A minor impact occurs when there is a predicted impact on macroinvertebrate abundance, density or composition that is within the usual variability for the site and which will recover within a short timescale.
- Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the macroinvertebrate community.

Data Requirements

The baseline for macroinvertebrates will be established from existing data together with a comparison of species flow preference and taxon abundance. The analysis will provide an assessment of the community type and its sensitivity.

Macroinvertebrate status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Macroinvertebrate data should include the LIFE and BMWP scores, together with abundance and density data where available. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) and other environmental variables as follows:

- Relevant study area (as identified by screening)
- Hydrology at or close to the monitoring sites to link to macroinvertebrate data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records
- Meteorology (where flow data insufficient) from available NRW / Environment Agency

rain gauges

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

Assessment Methodology and Uncertainty

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

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

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

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

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

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

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

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

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

NOTABLE SPECIES, DESIGNATED SITES AND OTHER SENSITIVE FAUNA AND FLORA

Potential Effects

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

Definition of Impacts

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

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

Table 1 Value of Ecological Receptor

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

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

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

otherwise stated in the feature assessment.

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

Table 2 Magnitude of Impact

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

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

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

Data Requirements

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

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

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

Assessment Methodology and Uncertainty

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

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

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

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

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

drawing on broad-scale evidence from other similar catchments.

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

Habitat Preferences

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

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

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

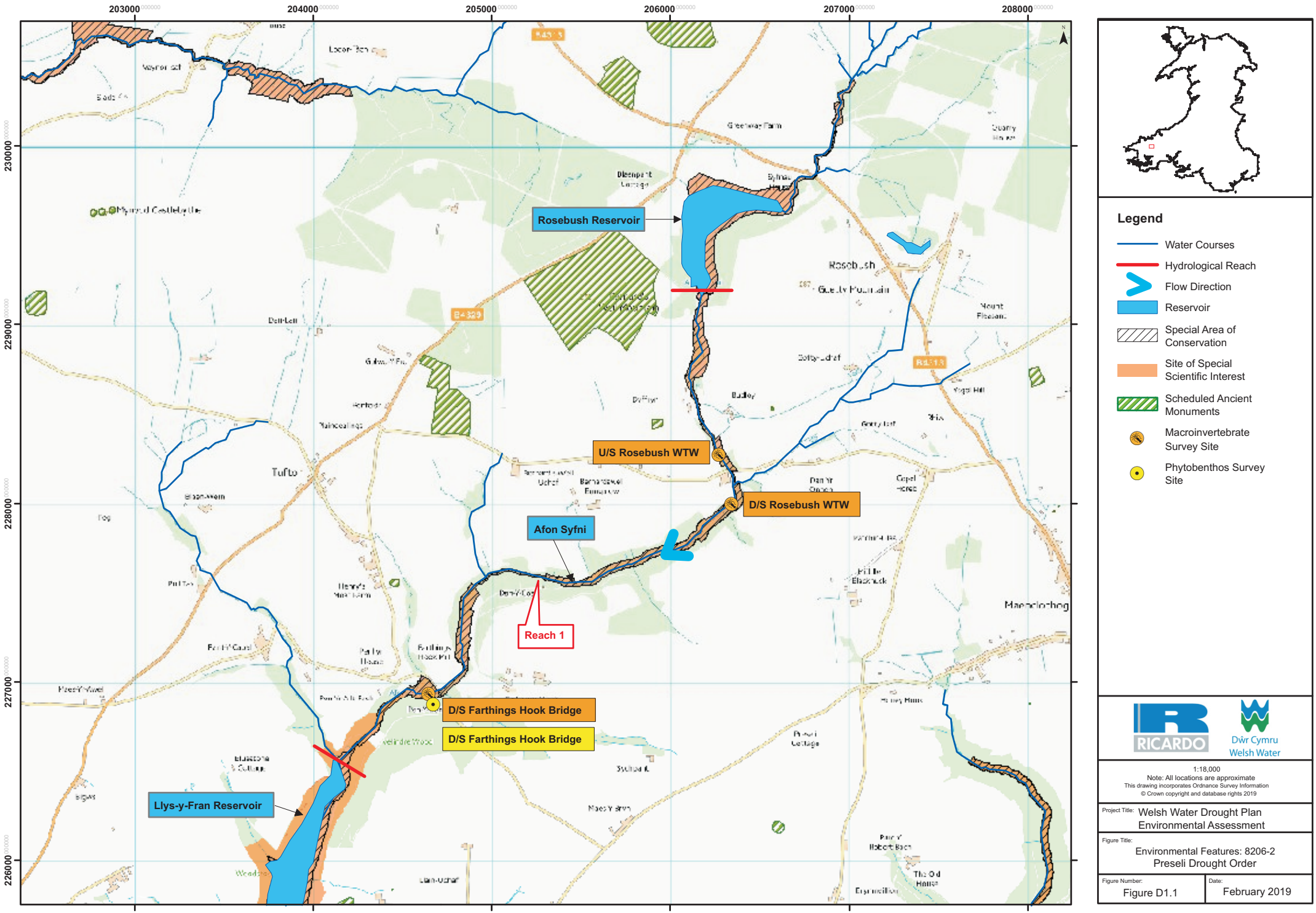
The ecological assessment has been undertaken recognising the Institute of Environmental Management and Assessment (IEMA)[1][2] and the Chartered Institute of Ecology and Environmental Management (CIEEM) study guidelines[3]. The assessment of impacts on other environmental receptors e.g. recreation and 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 Preseli Reservoir drought permit. Each feature assessment describes the analyses carried out and a statement of the assessed impact. All impacts are considered to be negative / adverse unless otherwise stated in the feature assessment.

This appendix is set out in the following sections:

Section D.2 Designated Sites
Section D.3 WFD Community Assessments

[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.



Legend

- Water Courses
- Hydrological Reach
- Flow Direction
- Reservoir
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments
- Macroinvertebrate Survey Site
- Phytobenthos Survey Site

RICARDO

Dŵr Cymru Welsh Water

1:18,000
Note: All locations are approximate
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Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Features: 8206-2 Preseli Drought Order

Figure Number: Figure D1.1

Date: February 2019

D2 DESIGNATED SITES

D.2.1 Eastern Cleddau SSSI/SAC

The Afon Syfynwy within which Reach 1 of the Preseli Reservoir drought permit is also located within the Eastern Cleddau Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) (**Table D2.1**). The Eastern Cleddau River is of special interest primarily for important populations of otter *Lutra lutra*, bullhead *Cottus gobio*, river lamprey *Lampetra fluviatilis* and brook lamprey *Lampetra planeri*. It is also of special interest for sea lamprey *Petromyzon marinus*; for its range of river habitats including beds of submerged aquatic plants often dominated by water-crowfoot *Ranunculus spp*, the aquatic plant *Potamogeton berchtoldii x P. polygonifolius(cf.),* as well as a variety of associated riverside habitats. Reach 1 is located within management unit 13 of the SAC, features which are significant to this unit are detailed in **Table D2.1**.

Table D2.1 Eastern Cleddau SAC and SSSI Features Located within Reach 1

River Cleddau (Eastern Cleddau)	**SAC Management Unit 13**
SAC Feature	
Brook lamprey	KS
River lamprey	X
Sea lamprey	X
Bullhead	Sym
Otter	KS
Alluvial forests	Sym
Ranunculion habitat	Sym
Active raised bogs	X
SSSI Features	
Potamogeton berchtoldii x *P.polygonifolius* (cf.)	X

Key for Table D2.1	
KS	Key species in the management unit
Sym	Features of importance the unit but are not the main focus of management or monitoring. These features will benefit from management for the key feature(s) identified in the unit. These may be classed as 'Sym' features because: • they are present in the unit but are of less conservation importance than the key feature; and/or • they are present in the unit but in small areas/numbers, with the bulk of the feature in other units of the site; and/or • their requirements are broader than and compatible with the management needs of the key feature(s).
x	Features not present in Management unit

The Afon Syfynwy is a major tributary of the Eastern Cleddau River, rising in the Preseli Hills, and flowing through two reservoirs, Rosebush and Llys y Fran. It is joined by tributaries of its own, the Deepford Brook, Rhyd-y-Brown Brook and Ty-Llosg Brook, before joining the

Eastern Cleddau near Gelli.

Above Rosebush Reservoir, the Afon Syfynwy flows between conifer plantation and heathland habitat. Rosebush Reservoir itself, the smaller of the two reservoirs, contains the aquatic plant six-stamened waterwort, *Elatine hexandra*, scattered over a 400m zone. The shore is dominated by shoreweed *Littorella uniflora* and is surrounded by conifer plantation, whereas fen and scrub surround the northern shore. Below Rosebush Reservoir, the river enters a densely vegetated gorge, flowing on through a small, steep-sided, predominantly wooded valley until it reaches the larger Llys y Fran reservoir. The river above Llys y Fran reservoir is heavily shaded, and consequently the diversity of aquatic vegetation is lower than expected and is dominated by a few lower plants, such as brook-side feather-moss and alpine water-moss, and the alga *Lemanea sp*. Hemlock water-dropwort is the most common higher plant along the channel margins. Much of the western shore of Llys y Fran Reservoir is lined with dense, semi-natural, broadleaved woodland. To the east, amenity grassland predominates, with areas of recently planted trees.

D.2.2 Assessment

Implementation of the Preseli Reservoir Drought Permit is expected to result in a 50% reduction in compensation release rate from Preseli Reservoir.This hydrological impact has been assessed as **major** for Reach 1, and is most likely to occur during the period August to November.

Implementation of this drought permit is expected to impact upon aquatic features of the Afon Syfynwy within Reach 1. The aquatic features of the Eastern Cleddau SAC/SSSI expected to be located within this reach include otter and *Ranunculion* habitat.

Ecological surveys carried out in 2005 in both the downstream stretch of the Afon Syfynwy between Rosebush and Llys y Fran Reservoirs (NGR SN063282) and at Mynydd-Du, upstream of Rosebush (NGR SN068298) did not record bullhead or brook lamprey[4]. There was no evidence to suggest that bullhead or brook lamprey species have inhabited the impacted reach within the past five years. APEM surveys in 2004 classified the habitat on the Afon Syfynwy between the Preseli Reservoir and Llys y Fran Reservoir as sub-optimal for lamprey ammocoetes, and no marginal silt beds (the key habitat requirement of lamprey ammocoetes) were found at either of the Habitats Directive fieldwork sites in 2005. Bullhead and brook lamprey are therefore screened out from further assessment.

European Otter

The Eastern Cleddau is one of the best rivers in Britain for otter, which are found on all the tributaries within the site. Otter are water-dependent, foraging in, over or adjacent to water for fish and aquatic invertebrates. However, this species are not expected to be significantly impacted by the drought permit implementation, as habitat availability and quality for otter is

[4] Environment Agency Wales (2007). Afonydd Cleddau Habitats Directive Review of Consents Stage 3b Licence Review Document. HWM_HD_Cleddau_06_C_002. October 2007 version 4.2

not anticipated to be significantly altered. As such, impacts to this feature are assessed as **negligible**.

Ranunculion habitat

The Syfynwy in Reach 1 is heavily shaded and consequently the diversity of aquatic vegetation is lower than expected and is dominated by a few lower plants, such as brook-side feather-moss and alpine water-moss, and the alga *Lemanea sp*. This reach is therefore not expected to represent good *Ranunculion* habitat, and therefore impacts to this feature are assessed as **negligible.**

Summary

The potential impacts of the Preseli Reservoir drought permit on the SAC and SSSI features are summarised in **Table D2.2**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability; see Section 4.3 of the main report) and the sensitivities of the key species of the designated site. The impacts presented in **Table D2.2** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.2 Summary of Impacts on the Eastern Cleddau SAC/SSSI

Feature	Impact	Significance of Impact
Reach 1		
Eastern Cleddau SSSI and SAC management unit 13	• Impacts on otter and *Ranunculion* habitat as a result of reduced flows and associated changes to the physical environment	**Negligible**

D3 WFD STATUS AND COMMUNITY ASSESSMENT

D.3.1 Macrophytes

D.3.1.1 Baseline

No baseline data has been provided by Natural Resources Wales (NRW) for the Water Framework Directive (WFD) waterbody in within which the zone of influence for this drought permit is located. Reach 1 is located within GB110061038300 Syfynwy - headwaters to Llys y Fran, which was classified in 2018 interim Cycle 2 as Good for the overall waterbody. Whilst the macrophyte sub-element has not been classified, the macrophyte and phytobenthos combined element is classified as Good. Considering the absence of baseline information, the macrophyte community is predicted based upon the physical environment of the reach and informed by professional judgement. As such care is taken for this assessment, which also uses a precautionary approach.

With an average gradient of ~2.5% and slight sinuosity, this is a steep upland river which would be expected to be reflected by a macrophyte community with a high proportion of

species which are adapted to high energy flow and is likely to be dominated by bryophytes. The riparian zone is densely wooded and is expected to provide significant shading of the water course. As such, primary production within the waterbody is expected to be low due to limited light penetration, and this would be expected to be reflected by low overall cover values for the macrophyte community.

Between 2006 and 2015, the soluble reactive phosphorus (SRP) concentrations within the waterbody have largely been consistent with the standard to achieve good or high WFD status. In recent years there appears to have been a deterioration in this standard with numerous instances of SRP concentrations increasing to moderate standards. As such the macrophyte community which is expected to be present within the reach is likely to be composed of taxa which show preference for higher nutrient levels than would be predicted for this river type. This may include nutrient tolerant bryophytes and filamentous algae.

Notable Species

As no baseline macrophyte data was available for this drought permit, it was not possible to identify the presence of notable macrophyte species within the reach.

D.3.1.2 Assessment

The assessment of impacts on the macrophyte community should be considered in the context of the watercourse under baseline conditions. Whilst no data was available for Reach 1, the community present is predicted based on the physical environment within the zone of influence. As such, the macrophyte community in the hydrological zone of influence of the drought permit is predicted to be bryophyte dominated, adapted to high flow velocity and may be adapted to raised nutrient concentrations. Reduction in flows could affect macrophyte communities in a number of ways:

- Reduction in velocity favouring species adapted to slower flow conditions;
- Proliferation of filamentous algae due to decreases in velocity / increases in water temperature;
- Shading of macrophyte stands by epiphytic algae and floating macrophytes, due to decreases in velocity/increases in water temperature;
- Desiccation of macrophyte beds due to reduced wetted width and water depth;
- Encroachment of marginal emergent species into the channel; and
- 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.

The hydrological impact of a 50% reduction in compensation release rate from Preseli Reservoir has been assessed as **major adverse** for Reach 1 and is most likely to occur during the period August to November. The risk of water quality deterioration associated with SRP has been assessed as **medium**, and **low** for dissolved oxygen and ammonia during the period

of implementation for Reach 1 only.

Major 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 Syfynwy. Due to the potential change to wetted area, velocities, splash and humidity, which would occur during the latter months of the macrophyte growing season, operation of the drought permit has the potential to affect the condition, composition and extent of macrophyte communities. Low flows may also favour the proliferation of filamentous algae species due to changes in velocity, water temperature and nutrient (SRP) levels.

For Reach 1 (Afon Syfynwy from Preseli Reservoir outflow to Llys y Fran inflow), operation of the drought permit is predicted to result in major hydrological impacts, with a reduction of 50% of the low and extreme low flows (Q_{95} and Q_{99}) respectively. These impacts would be expected to have a significant effect on macrophyte habitat availability and quality above that experienced during natural drought during the duration of the drought permit.

Riverine bryophytes (i.e. the functional group which is expected to dominate the community within Reach 1) are generally well adapted to tolerate desiccation and rewetting, and communities can take a long time to react to changes in environmental conditions[5]. However, given the magnitude of the drought permit, the effects could be significant enough to alter the composition/condition of the macrophyte community during the duration of the drought permit, particularly in relation to filamentous algal levels.

Bryophytes can be considered highly sensitive to nutrient enrichment. A medium risk of deterioration to SRP in Reach 1 could increase the occurrence of more opportunistic, nutrient tolerant taxa, epiphytes, and filamentous algae. In turn, this could affect macrophyte condition or potentially community composition if slower growing species or those that prefer lower nutrient conditions are outcompeted. Considering the medium risk of deterioration, these subsequent impacts may be sufficient to significantly alter the community composition within the reach.

However, this assessment is based on the premise that the drought permit is limited to a maximum of four months duration and is expected to occur during August to November, and is an isolated hydrological impact, i.e. no extension or repetition of the drought permit is considered. If an extension or repetition of the drought permit were required, this could not proceed without consideration of further impacts. It is therefore expected that effects of the drought permit on the macrophyte community would be limited by the short duration of the order, and reversed within one to two growing seasons following return to the normal hydrological regime. Therefore, considering the 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 **moderate**.

[5] Demars, B. O. L. and Britton, A. (2011). Assessing the impacts of small scale hydroelectric schemes on rare bryophytes and lichens. *Scottish Natural Heritage and Macaulay Land Use Institute Funded Report. Scottish Natural Heritage Commissioned Report No.421*

Summary

The potential impacts of the Preseli Reservoir drought permit on the macrophyte community are summarised in **Table D3.1**. 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 D3.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.1 Summary of Impacts on Macrophyte Community

Feature	Impact	Significance of Impact
Reach 1 - Afon Syfynwy from Preseli Reservoir outflow to Llys y Fran inflow		
Macrophytes	• Reduction in growth as a result of major impacts on water levels and flows. • Changes to community composition due to changes to flow velocities and habitat loss due to reduction in wetted width and depth. • Increase in detrimental smothering by filamentous algae levels increasing due to an increase in nutrients, increases in water temperature and decreased velocity	**Moderate**

Whilst the macrophyte sub-element has not been classified, the macrophyte and phytobenthos combined element of the GB110061038300 Syfynwy headwaters to Llys y Fran WFD waterbody is classified as Good.

It is considered likely that the drought permit could pose a **moderate** risk of deterioration in WFD status in relation to macrophytes for waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran, during the duration of the drought permit. However, effects would be expected to be temporary and reversible following return to a normal hydrological regime.

D.3.2 Macroinvertebrates

D.3.2.1 Baseline

Baseline data has been provided by NRW for the WFD waterbody within which the impacted reach for this drought permit is located. Waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran provides three NRW baseline macrophyte sampling locations which are located within Reach 1, i.e. U/S Rosebush WTW, D/S Rosebush WTW and D/S Farthings Hook Bridge. Data is available from these sites between 2005 and 2015 (data collected before 2005 was not used in this assessment).

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 2015, macroinvertebrates were identified to family level. For data collected in 2015, 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

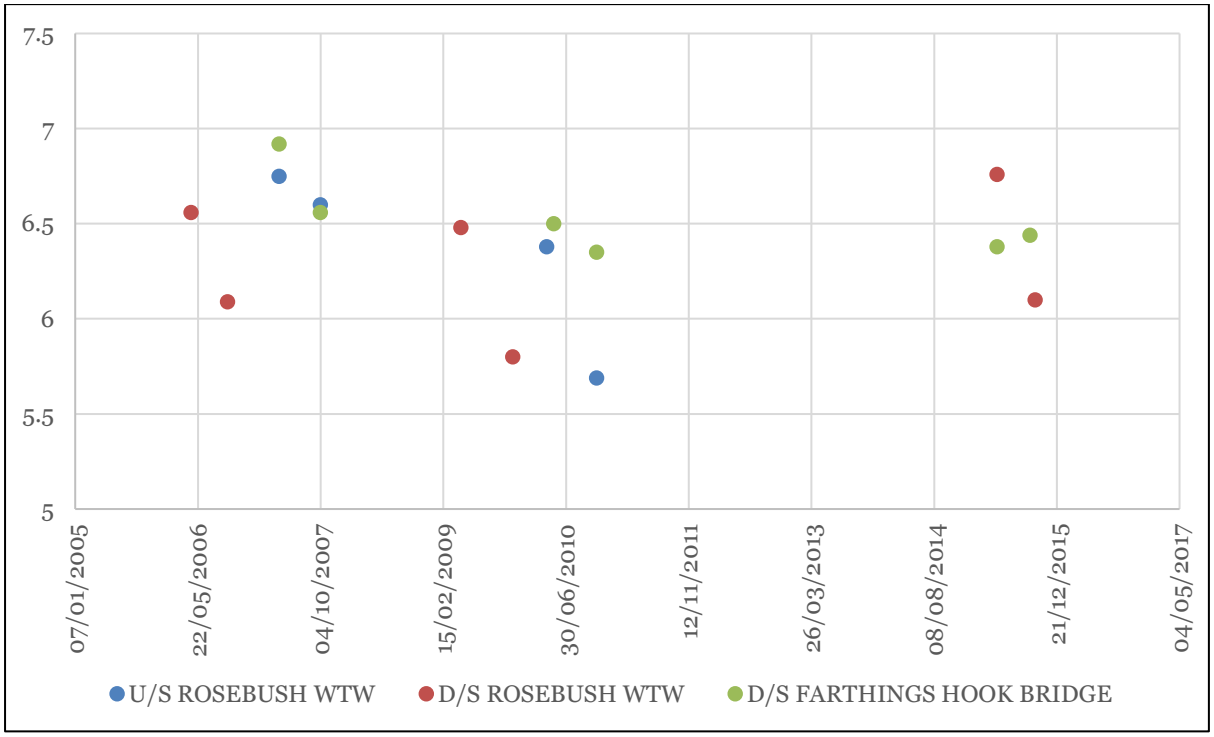
Invertebrate Flow Evaluation (LIFE); and number of taxa (NTAXA).

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 five represent macroinvertebrate communities living in good water quality. Scores below five indicate water quality stress on the macroinvertebrate community.

Overall, the macroinvertebrate community is relatively diverse, dominated by EPT (Ephemoptera, Plecoptera and Tricoptera) river fly species as would be expected for this type of upland river.

The ASPT scores obtained from the three sites range between 5.69 and 6.92 during the period 2005 to 2015 (**Figure D3.1**). This reflects a macroinvertebrate community which is consistent with that found in high water quality. In this upland waterbody with regulated flows from the upstream reservoir this community meets expectation. The community is exemplified by the presence of highly pollution sensitive species including the cased caddis *Silo pallipes*, olive upright *Rhithrogena semicolorata* and the stonefly *Perlodes microcephala,* which are found on a consistent basis.

Figure D3.1 ASPT Scores for Sites Located in Waterbody GB110061038300 Syfynwy - Headwaters to Llys y Fran



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 D3.2** for interpretation.

Table D3.2 Interpretation of Macroinvertebrate Community LIFE Scores

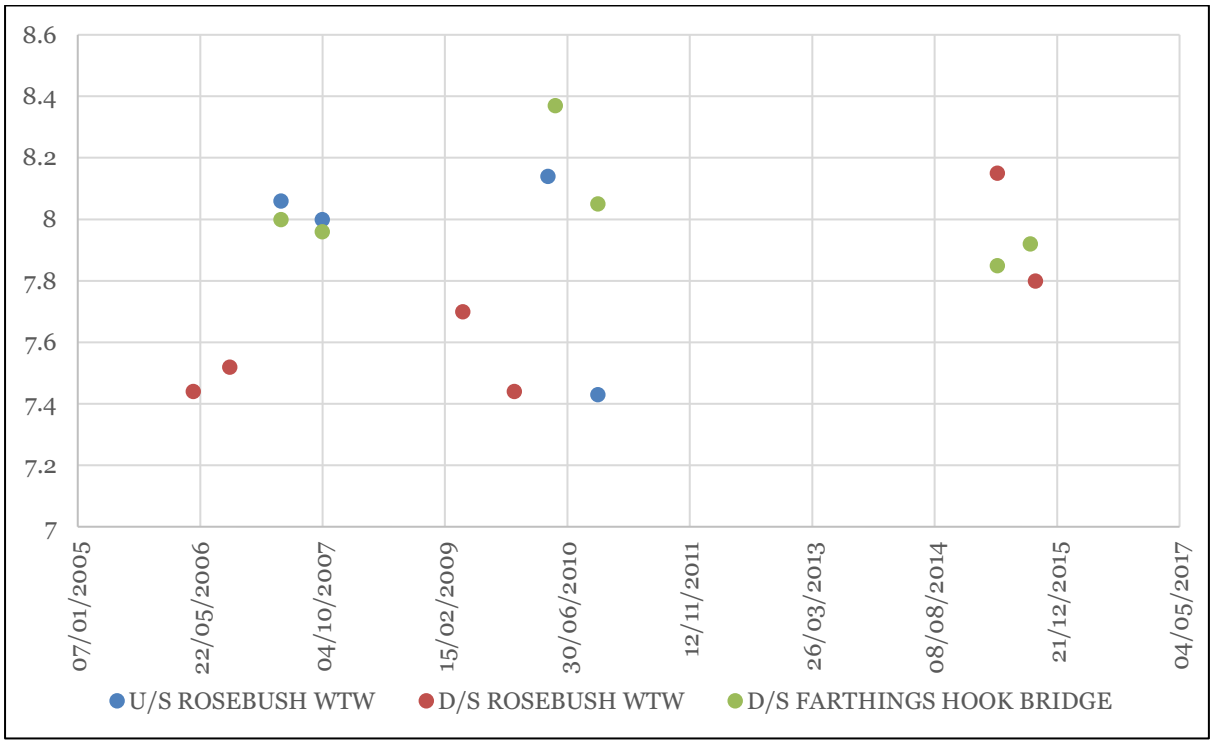
LIFE score	Invertebrate community flow sensitivity
7.26 and above	High sensitivity to reduced flows
6.51 – 7.25	Moderately sensitive to reduced flows
6.5 and below	Low sensitivity to reduce flows

LIFE scores obtained from the three sites in Reach 1 range between 7.43 and 8.37 (**Figure D3.2**). This describes a macroinvertebrate community which is highly sensitive to reduced flows and therefore is consistent with that found in fast flowing water. There is no evidence for flow variation at this site based on this data, which is expected from the consistent nature of the regulated flows from the upstream reservoir.

Notable Species

There were no notable species of macroinvertebrates present in the available NRW data for the three sites located in Reach 1.

Figure D3.2 Family LIFE Scores Obtained from Sites Located in Waterbody GB110061038300 Syfynwy - Headwaters to Llys y Fran



D.3.2.2 Assessment

The hydrological impact of a 50% reduction in compensation release rate from Preseli Reservoir has been assessed as **major** for Reach 1 and is expected to be in operation during August to November.

The 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 upper Afon Syfynwy.

Reduction in flow can modify the distribution and availability of in-stream habitat, such that detrimental effects on macroinvertebrates are possible. Marginal habitats are the most sensitive to flow reduction, with many slow-flow favouring species such as molluscs utilising this habitat. Depending on the rate of flow reduction, species in these marginal sediments may become stranded and ultimately die. Reproduction may also be impacted, in the autumnal months of the drought permit period low flows 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 recruitment may therefore be reduced. Baseline data from Reach 1 describes a macroinvertebrate community which is highly sensitive to reduced flows, with a high proportion of species preferring fast flowing water.

For Reach 1, operation of the drought permit is predicted to result in major hydrological impacts, with a reduction of 50% of the summer low and very low flows (Q_{95} and Q_{99}). This

magnitude of flow change would be expected to have significant effects on velocities, wetted width and depth and therefore habitat availability, particularly in flow sensitive areas of the channel, e.g. riffles, which form important habitat for macroinvertebrate species.

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. Although this effect would occur during drought under normal operating conditions, the operation of the drought permit is likely to magnify this effect as the availability of habitat niches and velocities is further reduced. This is likely to be reflected by reduced LIFE scores and the number of taxa (species richness).

In addition to effects on velocity and habitat availability, the drought permit has been assessed as having a low risk of deterioration to ammonia and dissolved oxygen, and moderate risk to SRP during drought permit implementation in Reach 1. This may manifest as a small reduction in pollution sensitive taxa in this reach. Taxa from families such as Leuctridae, Perlodidae, and Heptageniidae which require high levels of dissolved oxygen will be most susceptible. BMWP and ASPT scores from a community impacted by this pressure will be slightly reduced. A number of crustacean taxa such as the freshwater shrimps (Gammaridae) are particularly sensitive to ammonia. Consequently, there is potential that in the short-term this impact will modify the macroinvertebrate community with a reduction in abundance of ammonia sensitive species.

Potential impacts on SRP concentrations in Reach 1 are assessed as medium. SRP is not expected to have a direct impact on the macroinvertebrate community, although proliferation of algal communities in response to elevated nutrients may have indirect effects, for example with fluctuations in diurnal dissolved oxygen saturation as a response to increased primary production having a deleterious effect on sensitive taxa.

However, restoration of favourable ammonia, dissolved oxygen conditions and SRP concentrations is predicted following a recovery of flow. Hence, given the ability of macroinvertebrate communities to recover as a result of effective re-colonisation strategies, the magnitude of impact of water quality changes is considered to be low.

Typically, invertebrate communities can recover rapidly from short term flow impacts as a result of immigration from upstream habitats. In the context of the Syfynwy, recovery of the invertebrates will benefit from a number of unaffected tributaries which join the watercourse along its impacts reaches. However recolonization from upstream of the Syfynwy is likely to be impaired by the reservoir, which will act as a barrier for downstream movement of flow sensitive taxa. 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 compensation flow will likely be rapid.

Overall therefore, due primarily to the major hydrological impact of the drought permit, the potential impact to macroinvertebrate communities in Reach 1 is assessed as **moderate**, adverse, short term and reversible.

Summary

The potential impacts of the Preseli Reservoir drought permit on the macroinvertebrate community are summarised in **Table D3.3**. 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 D3.3** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.3 Summary of Impacts on Macroinvertebrate Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Syfynwy from Preseli Reservoir outflow to Llys y Fran inflow		
Macroinvertebrates	• Reduction in species diversity and abundance as a result of reduced recruitment. • Reduction in species diversity as a result of the loss of flow-sensitive taxa • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Reduction in species diversity as a result of deterioration to water quality	**Moderate**

The macroinvertebrate element of the GB110061038300 Syfynwy - headwaters to Llys y Fran WFD waterbody is classified as High in the interim 2018 Cycle 2. The overall waterbody status is Good. It is considered likely that the drought permit could pose a **moderate** risk of deterioration in WFD status in relation to macroinvertebrates for waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran, during the duration of the drought permit. However, effects would be expected to be temporary and reversible following return to a normal hydrological regime.

D.3.3 Fish

D.3.3.1 Baseline

The Eastern Cleddau catchment, including the hydrological zone of influence, is designated as part of the Cleddau Rivers SAC and Eastern Cleddau River SSSI. The Annex II species that are a primary reason for selection of the SAC are brook lamprey *Lampetra planeri*, river lamprey *Lampetra fluviatilis* and bullhead *Cottus gobio*. Sea lamprey *Petromyzon marinus* are also included in the citation as an Annex II species present as a qualifying feature, but are not a primary reason for site selection.

No fish survey data were made available for the Afon Syfynwy within the hydrological zone of influence (between Preseli Reservoir and Llys y Fran Reservoir). The Afon Syfynwy downstream of Llys y Fran dam is relatively well studied, however, the dam acts as a complete barrier to migration and so diadromous species such as Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, river lamprey and sea lamprey are therefore excluded from the impacted reach

and no further assessment has been undertaken.

The Environment Agency Wales Habitats Directive review in 2007[6] notes fish surveys carried out in 2005 in both the downstream stretch of the Afon Syfynwy between Rosebush and Llys y Fran Reservoirs (NGR SN063282) and at Mynydd-Du, upstream of Rosebush (NGR SN068298) recorded brown trout *Salmo trutta* only. There was no evidence to suggest that bullhead or brook lamprey species have inhabited the impacted reach within the past five years. APEM surveys in 2004 classified the habitat on the Afon Syfynwy between the Preseli Reservoir and Llys y Fran Reservoir as sub-optimal for lamprey ammocoetes, and no marginal silt beds (the key habitat requirement of lamprey ammocoetes) were found at either of the Habitats Directive fieldwork sites in 2005. Therefore, brown trout are the only species of fish included in the assessment.

The available data is not sufficient to adequately describe the fisheries baseline or to assess any impacts of the operation of a drought permit over and above the effects of a natural drought. A monitoring programme is required to gain an understanding of current status and seasonal variations of fish populations in this reach of the Afon Syfynwy. A suitable monitoring programme was described in the EMP[7]. Given the absence of adequate data, the following assessment should be interpreted with caution and considered as indicative only.

The fish element of the Syfynwy - headwaters to Llys y Fran waterbody (GB110061038300) was assessed as High status (uncertain) in the interim 2018 cycle 2 classification.

D.3.3.2 Assessment

The hydrological impact of a 50% reduction in compensation release rate from Preseli Reservoir has been assessed as **major** for Reach 1 and is expected to be in operation during August to November. There is very limited flow accretion in the reach and therefore the effect is likely to be sustained throughout Reach 1. A significant reduction in wetted width and depth is predicted.

<u>Brown Trout</u>

Juvenile Brown Trout

There is the potential for reduced flow to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of juvenile habitat. Provided minimum low flows are available, juvenile brown/sea trout are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible for Reach 1. The impact on juvenile brown trout is therefore considered to be **major adverse**

6 Environment Agency Wales (2007). Afonydd Cleddau Habitats Directive Review of Consents Stage 3b Licence Review Document. HWM_HD_Cleddau_06_C_002. October 2007 version 4.2
7 Cascade (2007). Provision of an Environmental Monitoring Plan. Environmental Monitoring Plan for Preseli Reservoir (SW6). 5th June 2007. A report for Dŵr Cymru Welsh Water.

in Reach 1.

Spawning Life Stage

Brown trout spawn in winter (November to December) and egg incubation and the early life stages (alevins) remain in situ in gravels until the spring. A reduction in wetted with and depth may results in the loss of suitable/key spawning habitats. Only the latter months of the drought permit could interact with the spawning life stage. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible for Reach 1. The impact on the spawning life stage of brown trout is considered to be **minor adverse** in Reach 1.

Adult Habitat and Migration

Brown trout require glides, runs and pool habitats, and are territorial in nature. As wetted width and depth is reduced during a drought permit, adult habitat availability is likely to decrease, in-turn resulting in an increase in competition and stress. The impact is considered to be of high magnitude, short-term, temporary and reversible for Reach 1.

Brown trout typically migrate in late summer/early autumn in search of suitable spawning grounds, therefore coinciding with the August to November drought permit implementation period. A reduction in wetted width and depth may hinder passage beyond any in-channel obstructions, therefore limiting recruitment potential in the reach. However, brown trout are unlikely to migrate during periods of low flow, therefore the impact is considered to be of medium magnitude, short-term, temporary and reversible for Reach 1. The impact on adult brown trout habitat and migration is considered to be **major adverse** in Reach 1.

Water Quality

The risk of a deterioration in dissolved oxygen (D.O.) and ammonia have been assessed as low, and SRP medium. Low D.O. and elevated ammonia levels can directly affect the health of the individual, whilst increased concentrations of SRP may result in indirect affects (e.g. smothering of gravel spawning substrates by algae adversely impacts recruitment). As the medium risk of increased SRP occurring during the pre-spawning life stage, recruitment of brown trout could be adversely impacted. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible for Reach 1. The impact on brown trout is therefore considered to be **moderate adverse** in Reach 1.

Summary

The potential impacts of the Preseli Reservoir drought permit on the fish 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 fish 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 the Fish Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Syfynwy from Preseli Reservoir outflow to Llys y Fran inflow		
Brown/sea trout	• Delays and potential cessation of adult upstream migration due to reduced flows and a reduction in adult habitat availability	**Major**
	• Reduction in recruitment due to the reduction/loss of suitable spawning habitat	**Minor**
	• Reduced water quality	**Moderate**
	• Reduction in juvenile survival due to habitat loss.	**Major**

D.3.4 Diatoms

D.3.4.1 Baseline

Baseline data has been provided by NRW for the WFD waterbody within which the impacted reach for this drought permit is located. Waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran provides one NRW diatom sampling location; D/S Farthing Hook Bridge, located within Reach 1. Data is available for spring and autumn 2015 only. This provides an up to date representation of the diatom community present in the reach, however it does not provide insight into the spatial and temporal variation within the reach which can be related to variation in the physical environment. Considering these constraints on the baseline information, care must be taken in their interpretation, and further baseline monitoring is recommended in order to better understand the phytobenthos community in Reach 1.

The Trophic Phytobenthos Index (TDI) describes the nutrient preferences of a phytobenthos community (**Table 3.4**). It ranges from 1 (preference for extremely low nutrient levels) to 100 (preference for extremely high nutrient levels). The data provided were used to calculate TDI4 scores, with TDI4 being the most recent version of the index. Percentage Motile Taxa is also provided, this gives the relative proportions of phytobenthos taxa within the community which are motile. When there are high numbers of motile taxa, this can indicate that light availability is influencing the community, this can be brought about by pressures such as siltation and high covers of filamentous algae.

Table D3.4 Diatom Metrics for Sites Located in Waterbody GB110061038300 Syfynwy - Headwaters to Llys y Fran

Site/Station Name	Sample Date	River TDI4	Motile%
D/S FARTHINGS HOOK BRIDGE	21-Apr-15	29.14	11
	02-Sep-15	26.86	2

The phytobenthos community present at the site D/S Farthing Hook Bridge was typical of upland, relatively high velocity rivers. Samples from 2015 showed a community with high proportion of *Achnanthidium sp.*, which are common and often abundant in upland streams

with mobile substrates. The overall species composition of the phytobenthos community is typical of the upper and mid reaches of upland, relatively high velocity rivers.

TDI4 scores, which range from 26.86 to 29.14 in autumn and spring respectively at the site D/S Farthing Hook Bridge, suggest relatively low nutrient levels consistent with oligo-mesotrophic conditions. SRP concentrations were largely consistent with the standard to support high status for invertebrates throughout the zone of influence of the Preseli Reservoir drought permit, however, recent increases in SRP show deterioration to standards consistent with moderate WFD status. However, this does not appear to have been reflected in the diatom community in 2015. Low scores for Percentage Motile Taxa indicate pressures such as siltation are not acting upon the phytobenthos community in Reach 1.

D.3.4.2 Assessment

Impacts on the phytobenthos assemblages of Reach 1 could occur due to 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.

WFD Ecological Quality Ratio (EQR) metrics for phytobenthos (TDI4 in DARLEQ)[8] are designed to detect differences in nutrient levels, particularly SRP. Implementation of the drought permit in Reach 1 is expected to result in a medium risk to SRP deterioration. An increase in SRP is likely to affect the phytobenthos community in terms of TDI score and associated WFD status. Considering the medium risk to SRP deterioration and the high sensitivity of the phytobenthos community to increased SRP concentration, the community composition may alter towards a higher proportion of taxa which favour increased nutrient concentrations.

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 **moderate adverse** for Reach 1. All impacts are deemed short term and reversible.

Summary

The potential impacts of the Preseli Reservoir drought permit on the phytobenthos community are summarised in **Table D3.5**. 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

[8] WFD-UKTAG (2014) Phytobenthos: Phytobenthoss for Assessing River and Lake Ecological Quality (River DARLEQ2)

Section 4.3 of the main report) and the sensitivities of the phytobenthos community. The impacts presented in **Table D3.5** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.5 Summary of Impacts on Phytobenthos Community

Feature	Impact	Significance of Impact
Reach 1 – Afon Syfynwy from Preseli Reservoir outflow to Llys y Fran inflow		
Phytobenthos	• Decrease in flow affecting phytobenthos community composition • Medium risk of deterioration to SRP affecting phytobenthos community composition and TDI score • Increases in filamentous algae smothering the substrate.	**Moderate**

The diatom element of the WFD waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran is classified as Good in the interim 2018 Cycle 2. The overall waterbody status is Good.

It is considered likely that the drought permit could pose a **moderate** risk of deterioration in WFD status in relation to the diatom element for waterbody GB110061038300 Syfynwy - headwaters to Llys y Fran, during the duration of the drought permit. However, effects would be expected to be temporary and reversible following return to a normal hydrological regime.